APPENDIX

A. THE PROTOTYPE SAMPLE

A.1. *Minor bodies*

We classify Solar System minor bodies according to both orbital family and composition, with a small number of additional subtypes. Minor bodies of specific compositions might be selected by ETIs for mining (c.f., Papagiannis 1978). From a SETI perspective, orbital families might be targeted by ETI probes to provide a unique vantage point over bodies like the Earth, or because they are dynamically stable for long periods of time and could accumulate a large number of artifacts (e.g., Benford 2019). There is a large overlap in some cases between spectral and orbital groups (as in DeMeo & Carry 2014), as with the E-belt and E-type asteroids, for which we use the same Prototype.

For asteroids, our spectral-type system is largely taken from Tholen (1984) (see also Tedesco et al. 1989). We selected those types considered the most significant by Tholen (1984), adding those unique to one or a few members. Some intermediate classes that blend into larger "complexes" in the more recent Bus & Binzel (2002) taxonomy were omitted. In choosing the Prototypes, we were guided by the classifications of Tholen (1984), Tedesco et al. (1989), and Bus & Binzel (2002).

The comet orbital classifications were informed by Levison (1996).

"Distant minor planets", adapting the "distant objects" term used by the Minor Planet Center,[1] refer to outer Solar System bodies beyond the Jupiter Trojans that are not comets. The spectral type system is that of Barucci et al. (2005) and Fulchignoni et al. (2008), with the latter guiding our Prototype selection. The division into orbital groups is based on the system in Gladman et al. (2008), which we consulted especially when selecting Scattered Disk and Detached objects. We aimed to select Prototypes that are almost certainly minor bodies and not dwarf planets, as indicated by a "probably not dwarf planet" designation on Mike Brown's website.[2]

The small classification system for satellites into regular, irregular, and "collisional shards" in Burns (1986) informs our classification.

Hughes et al. (2018) informed our grouping of debris disks into cold, warm, and hot/exozodis.

A.2. *Solid planetoids*

Planets were classed according to size and stellar insolation. *Kepler* result papers classifies planets by radius into: Earths (< 1.25 $R_\oplus$), Super-Earths (1.25–2 $R_\oplus$), Neptunes (2–6 $R_\oplus$), Jupiters (6–15 $R_\oplus$), and non-planetary (> 15 $R_\oplus$) (Borucki et al. 2011; Batalha et al. 2013). We adjusted this scheme by: (1) setting the boundary between solid super-Earths and giant Neptunes at 1.5 $R_\oplus$, except when density is known (Rogers 2015; Fulton et al. 2017); (2) adding a sub-Earth category for radii < 0.75 $R_\oplus$ to cover planets like Mars where the habitability prospects are likely different (e.g., Wordsworth 2016); (3) using the Weiss & Marcy (2014) relation to translate the radii categories into mass categories when no radius is available, using the mean $\sin i$ of $\pi/4$ as a guide. The mass categories for solid planetoids are sub-Earths ($\lesssim 0.4$ $M_\oplus$), Earth (~ 0.4–2 $M_\oplus$), and super-Earths (~ 2–4.5 $M_\oplus$, unless densities are known).

We use the terms "hot", "warm", "temperate", and "cold" to group by insolation. Cold planets are outside the conventional habitable zone (roughly taken to be $\lesssim 0.25$ Earth), temperate planets are within the conventional habitable zone (~ 0.25–2 Earth), warm planets are interior to the habitable zone but with insolations $\lesssim 100$ Earth, and hot planets have insolations $\gtrsim 100$ Earth. The distinction between "warm" and "hot" carries over from the giant planets, where warm planets around Sunlike stars are defined by period or semimajor axis (Dong et al. 2014; Huang et al. 2016; Petrovich & Tremaine 2016). The insolation range for "temperate" planets was chosen somewhat arbitrarily, partly to include Mars on the outside and leave no gaps with the "warm" planets as defined in the literature. Kopparapu et al. (2014) finds habitable zone boundaries that range from 0.8–1.4 Earth on the inside (generally near 1.0 AU) to 0.2–0.4 Earth on the outside. All the "temperate" Prototypes have insolations of 0.39–1.1 Earth, a more conservative range, except for the temperate Jupiter HD 93083b with 1.8 Earth.

[1] https://www.minorplanetcenter.net/iau/mpc.html

[2] http://web.gps.caltech.edu/~mbrown/dps.html

Dwarf planets in the Solar System are classed according to the spectral type and orbit, similarly to minor bodies (Appendix A.1). With the exception of Sedna, only the IAU-recognized dwarf planets (Ceres, Pluto, Eris, Makemake, Haumea) are listed as dwarf planets.

We added a "geological" classification intended to very roughly sample the diversity of surface environments and histories in the Solar System, excluding the Earth itself.

A.3. *Giant planets*

Giant planets are classed according to insolation and size (see Appendix A.2). Where possible we use densities to distinguish between ice giants and gas giants. We also added a "Superjovian" category to cover a better range of planetary masses. In the literature, the minimum mass for "superjovians" has been defined as 1, 3, and 5 M_J (Clanton & Gaudi 2014; Johnson et al. 2009; Currie et al. 2014). We arbitrarily are guided by a threshold of ~ 3 M_J, and allow $M \sin i$ values of 2–10 M_J.

An additional subcategory classifies giant planets according to (non-main sequence) stellar host, with a final entry for a resonant chain system.

A.4. *Stars*

Our estimation is that the major distinction between different types of stars is based on evolutionary stage and stellar mass.

Low mass protostars and pre-main sequence stars are classed numerically in the literature as 0, I, II, and III according to obscuration, where II and III correspond to T Tauri stages (Lada 1987). We retain the distinction between class 0 and 1 protostars and T Tauri stars. High mass protostars are given their own categories.

Sub-brown dwarfs are too small to have fused deuterium but are believed to have formed similarly to stars, as opposed to giant planets (Caballero 2018).

Brown dwarfs and main sequence (MS) stars are classed by Harvard spectral type. Each spectral type is divided into early (0-3), mid (4-6), and late (7+) subdivisions. Where possible we chose spectral standards as Prototypes (Morgan & Keenan 1973; Kirkpatrick et al. 1991; Walborn et al. 2002; Kirkpatrick 2005; Burgasser et al. 2006). We also favored stars in I17, because we have already observed a wide range of B through mid-M dwarfs. For brown dwarfs, we also tried to choose those with a mass that was clearly below the hydrogen-burning limit.

Covering post-MS evolution is more complicated. Stars that are actually in distinct evolutionary stages can appear on the same place in the HR diagram, such as the red giant branch and the asymptotic giant branch. To start, we divided post-MS stars into mass groups with qualitatively different evolution:

- *Very low mass stars* (initial mass $\lesssim 0.2$ $M_\odot$) are not predicted to have a red giant phase, but no isolated post-MS examples are known (Laughlin et al. 1997).
- *Low mass stars* (initial mass $\sim$ 0.2–2.2 $M_\odot$) pass through a red giant branch (RGB) phase terminating in a helium flash in their degenerate cores. The RGB star rapidly ($\ll 10^6$ yr) transitions to a Core Helium Burning (CHeB) phase before ascending the Asymptotic Giant Branch (AGB). The ultimate remnant is a CO white dwarf.
- *Intermediate mass stars*[3] (initial mass $\sim$ 2.2–7 $M_\odot$) ascend the RGB but do not have a helium flash, settle gradually into the CHeB phase, possibly executing a "blue loop", before ascending the AGB. The ultimate remnant is a CO white dwarf (Karakas & Lattanzio 2014).
- *Transitional mass stars*[4] (initial mass $\sim$ 7–11 $M_\odot$) proceed similarly to the intermediate mass stars until the end of the AGB phase, whereupon they begin carbon burning as a super-AGB phase. Those with lower mass end as an ONeMg white dwarf, while larger ones may undergo electron capture supernovae and possibly leave behind neutron stars (Karakas & Lattanzio 2014; Woosley & Heger 2015; Jones et al. 2016). The division between these two fates is not precisely known, so we do not make the distinction.

[3] Karakas & Lattanzio (2014) calls these lower-intermediate mass stars.

[4] This term does not appear in the literature; we use it to indicate they have characteristics similar to smaller intermediate mass stars (no core collapse supernova) and massive stars (later stages of nuclear burning, possible neutron star remnants). Karakas & Lattanzio (2014) calls these stars middle- and massive-intermediate mass stars.

- *Massive stars* (initial mass $\sim$ 11–40 $M_\odot$) undergo later stages of core nuclear burning. They switch between being red and blue supergiants during these later stages (Gordon & Humphreys 2019). They may have pronounced mass loss that transforms them into Wolf-Rayet stars (Clark et al. 2012). Massive stars end with a core collapse leaving behind a neutron star or black hole (Heger et al. 2003).

- *Very massive stars* (initial mass $\gtrsim$ 40 $M_\odot$) leave the main sequence but are unable to become red supergiants, probably because of their extreme mass loss (Humphreys & Davidson 1979; Woosley et al. 2002). They instead become blue supergiants and blue hypergiants, and after the mass loss, Wolf-Rayet stars (Clark et al. 2012). The stellar remnant is a black hole or nothing at all (Heger et al. 2003).

ETIs living around stars in different groups would face different challenges when adapting to post-MS evolution (for example, the post-helium flash contraction would require large-scale migration over just a few millennia to remain in the habitable zone). For low- and intermediate-mass stars, we preferred to use *Gaia* benchmark stars with well-determined masses (Heiter et al. 2015).

The evolutionary stages are supplemented with stars with atypical characteristics, including chemically peculiar stars, Be stars with decretion disks, pulsar-like stars, Population II stars, and a collection of pulsational variables. Peculiar stars that are the result of stellar mergers are emphasized because of their diverse and unique evolutionary histories (e.g., Jeffery 2008; Heber 2016).

A.5. *Collapsed stars*

These are divided into white dwarfs, neutron stars, and black holes.

White dwarfs are mainly grouped according to mass (Liebert et al. 2005) or spectral type (Sion et al. 1983) with supplemental subtypes based on evolutionary, composition, magnetic, or variability characteristics.

Neutron stars are grouped primarily by their rotation rate and magnetic field. These parameters also control the emission we observe and are related to evolutionary state (e.g., Alpar et al. 1982; Olausen & Kaspi 2014).

Black holes are grouped by detection method. Only a few detached black holes are known with firm positions, and many candidates are disputed (e.g., El-Badry & Quataert 2020; van den Heuvel & Tauris 2020; Bodensteiner et al. 2020), constraining our choice of Prototypes.

A.6. *Interacting binary stars*

We group interacting binary stars powered by accretion by the nature of the mass donor and that of the recipient:

- *Semidetached and contact binaries* – both components are stars (i.e., not stellar remnants).

- *Symbiotic stars* – donor is a giant, recipient is a small early-type star or a white dwarf (Belczyński et al. 2000). Symbiotic systems including neutron stars are listed under X-ray binaries.

- *Cataclysmic variables* (CVs) – donor is a late-type dwarf star, recipient is a white dwarf. They are further divided by variability/eruption characteristics (Osaki 1996; Schaefer 2010) and white dwarf magnetic field interaction with the accretion disk (Patterson 1994). Closely related are the AM CVn binaries, where the donor is a helium star or white dwarf, and the close binary supersoft sources where the donor is a higher mass subgiant (Kahabka & van den Heuvel 1997).

- *X-ray binaries* – The recipient is a neutron star or black hole. They are further divided based on the mass of the donor (low mass or high mass), and still further by the mode of mass transfer and other characteristics (see especially Reig 2011; Kaaret et al. 2017). X-ray binaries with an extreme super-Eddington accretion rate or luminosity (including the ultraluminous X-ray sources) are given their own special subcategory. Two more empirical types where the recipient's nature is indeterminate round out the category.

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In a few cases, stellar outflows rather than accretion dominates the system. These include systems where shocks dominate the luminosity (like colliding wind binaries), and the spider pulsars where a formerly-accreting neutron star ablates its companion (e.g., Dubus 2013; Roberts 2013).

A.7. *Stellar groups*

We include non-interacting binary and multiple stars with other stellar groups like star clusters. As in Eggleton & Tokovinin (2008), they are distinguished from clusters by their hierarchical organization. Binary systems are well represented in the I17 catalog, and we do not try to capture all combinations of stellar types or separations. We specifically include double degenerate systems, however, which are not included in I17, and have the potential to be sites of ETI activity (Dyson 1963). A few binaries classified by how they are detected from Earth or physical effects (heartbeat, eclipsing and self-lensing, chromospherically active) are included when they indicate distinct physical phenomena could be exploited for observation coordination by ETIs; visual, astrometric, photometric, and beaming binaries are excluded, however.

Globular clusters are classified according to the orbit classification of Mackey & van den Bergh (2005); additional subtypes are based on internal structure and luminosity. Other stellar clusters are divided into massive super star clusters, "faint fuzzies", nuclear clusters (including former nuclei of dwarf galaxies), and open star clusters.

Some unbound stellar associations are also included, when well-studied examples were not too large on the sky to be practically observed.

A.8. *Interstellar medium and nebulae*

The interstellar medium (ISM) as a whole has a complicated turbulent structure, although it is classically divided into hot, warm, and cool and cold phases (e.g., Cox 2005). Some structures in the interstellar medium are too large to practically study with our facilities: the hot ISM, the loops, the warm ionized medium, and so on. In terms of the general ISM, we focus on molecular clouds and HII regions, which are relatively compact. These are classed according to column density into translucent and dark clouds, with the dark clouds further divided by scale. Molecular clouds have self-similar structure, and although they are sometimes labeled as complexes, clouds, clumps, and cores in the literature, the divisions are arbitrary (see Wu et al. 2010). HII regions formed within the molecular clouds are also included and likewise grouped by density/size (Habing & Israel 1979).

Most of the entries in this phylum are structures produced by outflows from central engines and their interaction with the general ISM. These are grouped according to the nature of the central engine.

Additionally, we include a bubble of cosmic rays to represent the nonthermal ISM, and two circumgalactic medium clouds that we judged practical to observe.

A.9. *Galaxies*

We regard the fundamental distinction between galaxies as based on their specific star-formation rate (sSFR), the ratio of star-formation rate and stellar mass. There is a natural division in this parameter plane that is robust out to high redshift (z) into quiescent galaxies, intermediate galaxies, "main sequence" star-forming galaxies, and starbursts (Brinchmann et al. 2004; Elbaz et al. 2011; Speagle et al. 2014; Renzini & Peng 2015). The first three categories translate into different features on a color-magnitude diagram: the red sequence, green valley, and blue cloud, respectively (e.g., Strateva et al. 2001; Wyder et al. 2007). The abundance of phenomena that might affect galactic habitability or could be used for astroengineering, like core collapse supernovae, is tied to sSFR. At low redshift, quiescent galaxies are associated with early-type morphologies (ellipticals, spheroidals, and lenticulars), while main sequence galaxies are associated with late-type morphologies (late-type spirals and irregulars), but the correlation is not exact and we specifically include outliers as subtypes. At $z \sim 0$, there is also a correlation with environment, with quiescent galaxies more often located in clusters, although we again include outliers.

Among the quiescent galaxies, there appears to be a robust division of most large ellipticals into two types: boxy/cored and disky/coreless. The division is based on surface brightness profiles, shape, and X-ray emission (Kormendy et al. 2009). A related division (not included in this version of the catalog) is between fast rotators and slow rotators, where (massive) slow rotators have the more boxy isophotes, brighter X-ray emission, and central light deficits of the boxy/cored ellipticals and the disky/coreless properties correlated with the fast rotators (Emsellem et al. 2007, 2011; Sarzi et al. 2013). The prototypes for the boxy/cored and disky/coreless galaxies were chosen to be unambiguous slow and fast rotators according to Emsellem et al. (2011). Small early-type galaxies tend to be divided into high-density compact galaxies and low-density dwarf galaxies. There is a vigorous debate in the literature about which are more likely to be the analogs of large ellipticals, and which form a separate sequence (e.g., Graham & Guzmán 2003; Kormendy & Bender 2012). Dwarf quiescent galaxies are arbitrarily divided into dwarf elliptical, spheroidal, and ultrafaint simply to cover a full range in mass.

Green valley galaxies are a heterogeneous class, and are here classed mainly by the mode of their passage through the "valley" (Salim 2014; Schawinski et al. 2014).

The blue main sequence galaxies are very diverse. Note the characteristic sSFR decreases with time since the Big Bang (Speagle et al. 2014): a galaxy that would be classified as main sequence at $z \sim 2$ would be considered a starburst now, and thus their $z \sim 0$ analogs are placed among the starbursts. In the present-day Universe, these are classified coarsely by morphology (see below for discussion of fine morphology types), with a few subtypes each of late spirals and irregulars. We chose Prototypes mainly based on having consistent morphological types between de Vaucouleurs et al. (1991), Karachentsev et al. (2013), Ann et al. (2015), and Buta et al. (2015).

High-redshift star-forming galaxies have been classified mainly by spectrophotometric characteristics (e.g., BzK galaxies satisfy certain criteria in $(B - z)$ and $(z - K)$ colors). These subtypes can include both main sequence and true starburst galaxies. Our choice of Prototypes is constricted by the need for them to be gravitationally lensed to boost our sensitivity. In some cases we were unable to find a likely candidate of a common class of high-redshift galaxies (particularly, no lensed main sequence Lyman Alpha Emitters or main sequence Lyman Break Galaxies).

Starbursts are those galaxies with sSFRs significantly above the typical sSFR of star-forming galaxies at their redshift (Elbaz et al. 2011). We group them into nuclear starbursts occurring in the centers of larger galaxies, and dwarf starbursts occurring in small galaxies. We also specifically include some relatively nearby starbursts noted to have properties analogous to high-z galaxies, in addition to some lensed starbursts at high redshift, to further constrain the possibility that habitability evolves with time.

Disturbed galaxies broadly fall into three types of unrelated origins: the ring galaxies (which themselves have diverse origins), interacting galaxies, and galaxies affected by ram pressure stripping in an intracluster medium.

We add a catchall class of "morphological subtypes", which includes examples of galaxies hosting many kinds of features, particularly those found in galactic disks. There are many morphological classification schemes for disk galaxies. The basic sequence from early to late types is universal (e.g., Hubble 1926) and is included in the previous classes. In many traditional systems, the disk galaxies are classified by the strengths of their bar patterns (de Vaucouleurs et al. 1991; Graham 2019). van den Bergh (1976) instead classifies them according to the prominence of their arms from spirals to "anemic" galaxies to lenticulars (Kormendy & Bender 2012). Spiral arms themselves come in a great many varieties, from grand design to flocculent varieties (Elmegreen & Elmegreen 1982). Added to this are many other obvious morphological features in disk galaxies: rings, pseudo-rings, lenses, plumes, and more, all with a number of variants (Buta et al. 2015). Each feature adds another dimension to parameter space. The resultant morphological types are lengthy and can vary from paper to paper. To avoid combinatorial explosion, we just have a list of possible features (see Buta et al. 2015, for detailed discussion of these features). Some galaxies here are Prototypes for several types to minimize the number of galaxies observed. Prototypes are chosen by their classification in Comerón et al. (2014) and Buta et al. (2015), especially if they are given as explicit examples of a morphology in Table 1 of Buta et al. (2015).

Finally, we include three types of galaxies defined by their relationships with their cosmic environment.

A.10. *AGNs*

There are a plethora of classification schemes for AGNs, as reviewed in Padovani et al. (2017). We use a canonical division of AGNs into the major divisions of LINERs, Seyferts, radio galaxies, quasars, and blazars as the foundation (e.g., Peterson 1997). Except for LINERs, these are further subdivided into the common categories inspired by optical and radio characteristics (as in Osterbrock 1977; Fanaroff & Riley 1974; Kellermann et al. 1989; Ghisellini et al. 2011, respectively). These main object types represent different luminosities, radio-loudness, and viewing angle, with some admitted overlap between the classes (Urry & Padovani 1995; Padovani et al. 2017).

Additional classes were added to cover objects with unusual spectral or morphological features, or the presence of multiple supermassive black holes.

A few auxiliary objects related to AGNs have also been included: megamasers and AGN relics (a voorwerp and a fossil AGN).

A.11. *Galaxy associations*

Galaxy associations are mainly classified by richness, from isolated pairs of galaxies through groups and clusters. Only compact and "fossil" groups are included due to practicality considerations, as neither of these types is vastly larger than a galaxy (Hickson 1993), whereas nearby galaxy groups cover too much of the sky to practically observe.

A very simple galaxy cluster classification scheme is used, based on relative symmetry and richness (compare with the more elaborate systems in Bahcall 1977). A high-redshift protocluster, a grouping which has not yet virialized at the time of observation, is in the sample.

To the structures themselves, we also included examples of features in the intracluster medium (ICM) of galaxy clusters, both thermal and nonthermal (e.g., Markevitch & Vikhlinin 2007; van Weeren et al. 2019).

A.12. *Large-scale structures*

Most large-scale structures (which include superclusters, voids, and "Great Walls" of galaxies) are too diffuse and large to observe practically. The included "attractor" and "repeller" points are not physical objects, but instead indicate local sinks and sources in the peculiar velocity of galaxies. They do roughly correspond to a dense group of clusters and a void, respectively (Hoffman et al. 2017), and may draw the attention of ETIs as special places.

A.13. *Technology*

Which active satellites are available for observation will depend on new launches and re-entries. Although we list some major classes of satellite, the selection of most of the individual sources will be opportunistic.

A.14. *Not real*

We include the Solar antipoint as a "source" because of its special significance in SETI. The Earth transits the Sun as seen by observers at stars in this direction. It has been suggested that ETIs that observe Earth transits would be especially motivated to broadcast in our direction because they know a habitable planet exists; furthermore, the transit itself can be used for synchronization (Shostak 2004; Heller & Pudritz 2016; Sheikh et al. 2020).

One each of the stable Earth-Moon and Earth-Sun Lagrange points is included. These points have been proposed as locations where probes may reside (Freitas & Valdes 1980; Benford 2019).

Like the Solar antipoint, the Galactic anticenter is included as a special point on the sky. Benford et al. (2010) proposes that ETIs would preferentially beam transmission to and away from the Galactic Center, since it defines a natural axis or corridor. Thus, we might then expect to see transmissions from ETIs further out in the disk than us from the location of the Galactic anticenter.

A.15. *Tables*

Table A1 lists the entire Prototype sample, organized by the type of objects they are supposed to represent.

We also list transient phenomena in Table A2, organized according to their predictability. Specific examples listed may not display the transient phenomenon at any one given time.

Table A1. Prototype sample

Type	Subtype	Prototype	ID	Solar?	Ref
		Minor body			
Asteroid	A-type	446 Aeternitas	001	✓	···
	C-type	52 Europa	002	✓	B02
	D-type	624 Hektor	003	✓	···
	E-type	434 Hungaria	004	✓	B02
	M-type	16 Psyche	005	✓	···
	O-type	3628 Božněmcová	006	✓	B02
	P-type	420 Bertholda	007	✓	···
	Q-type	1862 Apollo	008	✓	B02, T84
	R-type	349 Dembowska	009	✓	B02, T84
	S-type	15 Eunomia	010	✓	···
	T-type	233 Asterope	011	✓	···
	V-type	4 Vesta	012	✓	B02, T84
	Binary (double)	90 Antiope	013	✓	···

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	Asteroid satellite	Dactyl	014	✓	···
	Mercury-crossers	3200 Phaethon	015	✓	···
	Vatira	2020 AV_2	016	✓	···
	Venus co-orbital	(322756) 2001 CK_{32}	017	✓	···
	Atira	163693 Atira	018	✓	···
	Aten	3753 Cruithne	019	✓	···
	Arjuna	1991 VG	020	✓	···
	Apollo	1862 Apollo	008	✓	···
	Earth Trojan	2010 TK_7	021	✓	···
	Earth horseshoe	3753 Cruithne	019	✓	···
	Earth quasisatellite	(469219) Kamo'oalewa	022	✓	···
	Earth Kozai librator	4660 Nereus	023	✓	···
	Amor	433 Eros	024	✓	···
	Mars Trojan	5261 Eureka	025	✓	···
	Hungaria	434 Hungaria	004	✓	···
	Flora	8 Flora	026	✓	···
	Main Belt Zone I	4 Vesta	012	✓	···
	Phocaea	25 Phocaea	027	✓	···
	Main Belt Zone II	15 Eunomia	010	✓	···
	Main Belt Zone III	52 Europa	002	✓	···
	Cybele	65 Cybele	028	✓	···
	Hilda	153 Hilda	029	✓	···
	Jupiter Trojan	624 Hektor	003	✓	···
Comet	Typical composition	6P/d'Arrest	030	✓	···
	Carbon-chain depleted	21P/Giacobini-Zinner	031	✓	1
	Active	1P/Halley	032	✓	···
	Manx	C/2014 S3 (PAN-STARRS)	033	✓	···
	Extinct (Damocloid)	5335 Damocles	034	✓	2
	Falling evaporating bodies	β Pic	035		···
	Encke-type	2P/Encke	036	✓	···
	Main belt comet	133P/Elst-Pizarro	037	✓	3
	Jupiter-family	9P/Tempel 1	038	✓	···
	Chiron-type	95P/Chiron	039	✓	4
	Halley-type	1P/Halley	032	✓	···
	Long-period	153P/Ikeya-Zhang	040	✓	···
Distant minor planet	BB-type	(24835) 1995 SM_{55}	041	✓	···
	BR-type	(15788) 1993 SB	042	✓	···
	IR-type	(385185) 1993 RO	043	✓	···
	RR-type	15760 Albion	044	✓	···
	Binary	79360 Sila-Nunam	045	✓	···
	Centaur	2060 Chiron	039	✓	4
	Uranus Trojan	2011 QF_{99}	046	✓	···
	Neptune Trojan	2001 QR_{322}	047	✓	···
	Plutino	(385185) 1993 RO	043	✓	···
	Cold classical KBO	15760 Albion	044	✓	···
	Hot classical KBO	(523899) 1997 CV_{29}	048	✓	···
	Haumea family	(24835) 1995 SM_{55}	041	✓	···
	Twotino	(20161) 1996 TR_{66}	049	✓	···
	Scattered disk object	(91554) 1999 RZ_{215}	050	✓	···
	Detached object	(181902) 1999 RD_{215}	051	✓	···
	Sednoid	541132 Leleākūhonua	052	✓	···
Minor satellite	Rocky	Phobos	053	✓	···
	Icy	Amalthea	054	✓	···
	Egg	Methone	055	✓	···

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	Collisional shard	Amalthea	054	✓	···
	Irregular (prograde)	Himalia	056	✓	···
	Irregular (retrograde)	Phoebe	057	✓	···
	Trojan	Helene	058	✓	···
	Co-orbital	Epimetheus	059	✓	···
	Temporary Earth minimoon	2006 RH_{120}	060	✓	···
	Shepherd moon	Prometheus	061	✓	···
	Chaotic rotator	Hyperion	062	✓	···
Planetesimals	White dwarf bodies	WD 1145+017	063		···
Circumplanetary bodies	Planetary rings	Saturn	064	✓	···
	Ring arcs	Neptune	065	✓	···
	Lagrange point dust cloud	L_5 Kordylewsky cloud	066	✓	···
Interstellar	Comet	2I/Borisov	067	✓	···
	'Oumuamua-type	1I/'Oumuamua	068	✓	···
Protoplanetary disk		TW Hya	069		···
	Dippers	EPIC 203937317	070		···
Transitional disk		GM Aur	071		···
Debris disk	Cold (Kuiper-analog)	τ Cet	072		···
	Warm (asteroidal)	κ Psc	073		···
	Hot (exozodi)	Altair	074		···
	Extreme	NGC 2547 ID8	075		5
	Planetary collision	BD+20 307	076		···
	Post-stellar (rejuvenated)	NGC 7293 central star	077		···
	Post-stellar (tidal disruption)	G29-38	078		···
	Post-stellar (evaporation)	WD J0914+1914	079		···
		Solid planetoid			
Major planet	Mercury (warm)	Mercury	080	✓	···
	Supermercury	K2-229 b	081		···
	Sub-Earth (temperate)	Mars	082	✓	···
	Sub-Earth (warm)	Mercury	080	✓	···
	Sub-Earth (hot)	Kepler 444 d	083		···
	Earth (temperate)	Proxima b	084		···
	Earth (warm)	Venus	085	✓	···
	Earth (hot)	Kepler 78 b	086		···
	Superearth (cold)	Barnard's star b	087		···
	Superearth (temperate)	LHS 1140 b	088		···
	Superearth (warm)	HD 40307 f	089		···
	Superearth (hot)	55 Cnc e	090		···
	Resonant chain	TRAPPIST-1 bcdefg	091		···
Giant planet core		TOI 849 b	092		···
Disintegrating planet		KIC 12557548 b	093		6
Pulsar planet		PSR B1257+12 ABC	094		···
Dwarf planet	C-complex	1 Ceres	095	✓	···
	BB-type	136199 Eris	096	✓	···
	BR-type	134340 Pluto	097	✓	···
	RR-type	90377 Sedna	098	✓	···
	Main asteroid belt	1 Ceres	095	✓	···
	Plutino	134340 Pluto	097	✓	···
	Hot classical KBO	136472 Makemake	099	✓	···
	Haumea family	136108 Haumea	100	✓	···
	Detached	136199 Eris	096	✓	···
	Sednoid	90377 Sedna	098	✓	···
Major satellite	Rocky	Moon	101	✓	···

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	Icy	Titan	102	✓	···
	Retrograde	Triton	103	✓	···
	Resonant chain	Europa	104	✓	···
Geological classifications	Primordial	Callisto	105	✓	···
	Inactive	Ganymede	106	✓	···
	Solar	Mars	082	✓	···
	Convective	134340 Pluto	097	✓	···
	Hydrological	Titan	102	✓	···
	Stagnant lid	Venus	085	✓	···
	Tectonic	Europa	104	✓	···
	Cryovolcanic	Enceladus	107	✓	···
	Volcanic	Io	108	✓	···
		Giant planet			
Ice giant	Cold Neptune	Neptune	065	✓	···
	Temperate Neptune	Kepler 22 b	109		···
	Warm Neptune	GJ 436 b	110		···
	Hot Neptune	HATS-P-26 b	111		···
	Mini-Neptune	GJ 1214 b	112		···
Gas giant	Cold Jupiter	Jupiter	113	✓	···
	Temperate Jupiter	HD 93083 b	114		···
	Warm Jupiter	HATS-17 b	115		···
	Hot Jupiter	HD 189733 b	116		···
	Inflated	HD 209458 b	117		···
	Sub-Saturn	Kepler 18 d	118		···
Superjovian	Cold super-Jovian	HR 8799 bcde	119		···
	Temperate super-Jovian	HD 28185 b	120		···
	Warm super-Jovian	HD 80606 b	121		···
	Hot super-Jovian	HD 147506 b	122		···
Host classification	Giant host	Pollux b	123		7
	White dwarf	WD J0914+1914	079		···
	Neutron star	PSR B1620-26 (AB) b	124		···
	Circumbinary (non-interacting)	Kepler 16 b	125		···
	Post-common envelope	NN Ser cd	126		···
Orbital dynamics classes	Resonant chain	Kepler 223 bcde	127		···
		Star			
Protostars	Class 0	IRAS 16293-2422	128		···
	Class I	Elias 29	129		···
	High mass	IRAS 20126+4104	130		···
Pre-main sequence	T Tauri	TW Hya	069		···
	Herbig Ae/Be	AB Aur	131		8
	FU Orionis	FU Ori	132		9
Sub-brown dwarf	Early Y	WISE J085510.83-071442.5	133		···
Brown dwarf	Early Y	WISE J071322.55-291751.9	134		···
	Late T	2MASSI J0415195-093506	135		10
	Mid T	ϵ Ind Bb	136		···
	Early T	Luhman 16B	137		···
	Late L	Luhman 16A	138		···
	Mid L	HD 130948BC	139		11
	Early L	2MASSI J1506544+132106	140		12
	M	PPL 15	141		···
Main sequence	Early L	2MASS J0523-1403	142		···

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	Late M	VB 10	143		K91, 13
	Mid M	Wolf 359	144		K91, 13
	Early M	HD 95735	145		K91, 13
	Late K	61 Cyg B	146		K91, MK73
	Mid K	61 Cyg A	147		K91, G94, MK73
	Early K	ϵ Eri	148		G94
	Late G	τ Cet	072		···
	Mid G	κ_1 Cet	149		G94
	Early G	Sun	150	✓	G94, MK73
	Late F	β Vir	151		MK73
	Mid F	π_3 Ori	152		G94, MK73
	Early F	78 UMa	153		G94, MK73
	Late A	α Cep	154		···
	Mid A	Alcor	155		···
	Early A	Vega	156		G94, MK73
	Late B	λ Aql	157		···
	Mid B	α Gru	158		···
	Early B	η UMa	159		G94, MK73
	Late O	10 Lac	160		G94, MK73
	Mid O	HD 46150	161		MK73, 14
	Early O	HD 64568	162		14
Low mass subgiants	K	κ CrB	163		MK73
	G	μ Her	164		G94, MK73
	F	Procyon A	165		H15
	A	ι UMa	166		MK73
Low mass RGB	M	γ Cru	167		···
	Late K	Aldebaran	168		H15
	Early K	Arcturus	169		H15
Low mass CHeB	Red clump	α Ser	170		···
	Red horizontal branch	BD +17 3248	171		···
	RR Lyrae	RR Lyr	172		···
	Blue horizontal branch	HD 161817	173		···
Low-intermediate mass AGB	M	R Dor	174		···
	S (intrinsic)	RS Cnc	175		···
	C	IRC +10216	176		···
	OH/IR	IRC +10011	177		···
Low-mid mass post-AGB	Post-AGB	HD 44179	178		15
	Final flash	V4334 Sgr	179		···
Intermediate mass subgiant	B	Regulus	180		···
	Hertzsprung gap	Capella Ab	181		···
Intermediate mass RGB	K	α Hya	182		MK73
	M	α Cet	183		MK73
Intermediate mass giant	K supergiant	ζ Aur	184		···
	G giant	ϵ Vir	185		G94, MK73, H15
Intermediate mass CHeB	Red clump	Capella Aa	186		···
	Blue loop	δ Cep	187		···
	Classical Cepheid	δ Cep	187		···
Transitional mass giant	K supergiant	β Ara	188		H15
	G supergiant	l Car	189		···
	AF supergiant	Canopus	190		···
	Super-AGB	MSX SMC 055	191		···
Massive post-MS	OB giant	ι Ori AB	192		MK73
	Blue (B) supergiant	ζ Per	193		MK73
	White (BA) supergiant	Deneb	194		G94, MK73

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	Red supergiant	Betelgeuse	195		G94, MK73
	Yellow hypergiant	ρ Cas	196		16
	Cool hypergiant	VY CMa	197		17
Wolf-Rayet	WR N	EZ CMa	198		18
	WR C	γ_2 Vel	199		...
	WR O	WR 102	200		...
Very massive post-MS	B hypergiant	ζ_1 Sco	201		...
	LBV (S Dor type)	AG Car	202		19
	LBV (η Car type)	η Car	203		20
Chemically peculiar	Metallic-line (Am) star	ϵ Ser	204		...
	Magnetic Ap star	α_2 CVn	205		21
	HgMn star	α And A	206		...
	λ Boo star	λ Boo	207		...
Population II brown dwarf	sdL	2MASS J0532+8246	208		...
Population II subdwarf	sdM	Kapteyn's star	209		...
	sdK	Groombridge 1830	210		...
	sdG	BD -00 4470	211		...
	sdF	HD 84937	212		H15
Population II subgiant		HD 140283	213		H15
Extremely metal poor		HD 122563	214		...
	CEMP (intrinsic)	HE 0107-5240	215		...
Pulsational variable	Long-period variable	Mira A	216		22
	α Cygni variable	Deneb	194		23
	Cepheid	δ Cep	187		...
	RR Lyrae variable	RR Lyr	172		...
	δ Scuti variable	δ Sct	217		...
	γ Dor variable	γ Dor	218		24
	Slowly Pulsating B variable	53 Per	219		...
	β Cephei variable	β Cep	220		...
	Blue large amplitude pulsator	OGLE BLAP-009	221		...
	Slowly-pulsating sdBV	PG 1716+426	222		25
	Rapidly-pulsating sdBV	V361 Hya	223		26
	Pulsating sdO	SDSS J160043.6+074802.9	224		27
Flare star	dMe	UV Cet	225		28
	Superflare star	κ_1 Cet	149		...
	RS CVn-type flare star	HR 1099	226		...
Stellar pulsar	Ultracool pulsar	TVLM 513-46546	227		29
	mCP pulsar	CU Vir	228		...
Rotationally extreme	Classical Be	ζ Tau	229		...
Post-merger/interaction	Luminous red nova	V838 Mon	230		...
	Yellow straggler	M67-S1237	231		...
	FK Com	FK Com	232		...
	R CrB	R CrB	233		...
	Extreme helium	HD 124448	234		30
	Blue straggler	40 Cnc	235		...
	Hot subdwarf (sdB)	HD 149382	236		...
	Hot subdwarf (sdO)	BD+28 4211	237		...
	Helium subdwarf (He-sdOB)	PG 1544+488	238		30, 31
	Dwarf carbon	G77-61	239		...
High velocity	Runaway	ζ Oph	240		...
	Hyperrunaway (Ia SN)	HD 271791	241		...
	Hypervelocity (SMBH)	HVS 1	242		...
Collapsed star					

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
White dwarf	Extremely low mass	NLTT 11748	243		···
	Low mass	LAWD 32	244		···
	Typical mass	van Maanen 2	245		···
	Massive	Sirius B	246		···
	Ultramassive	GD 50	247		···
	Central star of PN	NGC 7293 central star	077		···
	Pre-white dwarf	PG 1159-035	248		32
	Partially burned inflated WD	GD 492	249		33
	Post-double degenerate inflated WD	D6-3	250		···
	Helium core	NLTT 11748	243		···
	ONeMg	QU Vul	251		34
	Hot DA	G191-B2B	252		35
	Mid DA	Sirius B	246		···
	Cool DA	LHS 253	253		···
	Hot DB	GD 358	254		36
	Mid DB	LAWD 87	255		···
	DC	Stein 2051B	256		···
	DZ	van Maanen 2	245		···
	DQ	LAWD 37	257		···
	DO	HZ 21	258		···
	Hot DQ	WD 1150+012	259		···
	Oxygen-line (Dox)	SDSS 1102+2054	260		···
	Magnetic	Grw $+70^{\circ}8247$	261		···
	Pulsating	ZZ Cet	262		···
	Blackbody	Ton 124	263		···
Neutron star	Compact central object	1E 1207.4-5209	264		···
	Radio-quiet pulsar	Geminga	265		37
	Radio-loud pulsar	Crab pulsar	266		···
	Optical pulsar	Crab pulsar	266		···
	Magnetar (radio quiet)	SGR 1806-20	267		···
	Magnetar (radio loud)	XTE J1810-197	268		···
	Magnetar (fast radio burster)	SGR 1935+2154	269		···
	Rotating radio transient	PSR B0656+14	270		···
	X-ray dim isolated NS	RX J1856.5-3754	271		···
	Millisecond pulsar	PSR J0437-4715	272		···
Black hole	Accreting	Cygnus X-1	273		···
	Detached (globular cluster)	NGC 3201 BH1	274		···
	Failed SN	NGC 6946-BH1	275		···
		Interacting binary star			
Semidetached	Algol-type	Algol	276		38
Contact binary	Shallow overcontact	W UMa	277		···
	Deep overcontact	FG Hya	278		···
	OO Aql	OO Aql	279		···
Symbiotic star	S-type	CH Cyg	280		···
	D-type	R Aqr	281		···
	Weakly symbiotic	Mira	216		···
	Symbiotic nova	RR Tel	282		39
	Supersoft source (symbiotic)	RR Tel	282		···
	Symbiotic recurrent nova	RS Oph	283		40
Cataclysmic variable	Dwarf nova	SS Cyg	284		41
	Novalike variable	UX UMa	285		42
	Recurrent nova (CV)	T Pyx	286		43

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	Old classical nova	GK Per	287		···
	Intermediate polar	DQ Her	288		···
	IP propeller	AE Aqr	289		···
	Polar	AM Her	290		···
	CV pulsar	AR Sco	291		···
AM CVn binary		AM CVn	292		···
Close binary SSS		QR And	293		···
Neutron star X-ray binary	Z source	Sco X-1	294		···
	Atoll source	4U 1608-52	295		···
	Type II burster	4U 1730-335	296		···
	Ultracompact LMXB	4U 1820-303	297		···
	Symbiotic LMXB	GX 1+4	298		···
	Accreting millisecond pulsar	SAX J1808.4-3658	299		···
	Transitional millisecond pulsar	PSR J1023+0038	300		···
	IMXB (NS)	Her X-1	301		···
	Be/X-ray binary (HMXB, NS)	A 0535+26	302		···
	Classical supergiant HMXB (NS)	Vela X-1	303		44
	Roche-lobe overflow HMXB (NS)	Cen X-3	304		···
	Symbiotic HMXB	4U 1954+31	305		···
Black hole XRB	Black hole LMXB	V404 Cyg	306		45
	Be/X-ray binary (BH)	MCW 656	307		···
	Supergiant HMXB (BH)	Cyg X-1	273		···
Microquasar	Microquasar	GRS 1915+105	308		46
Supercritical XRB	Faint supercritical	SS433	309		···
	Non-pulsating ULX	M82 X-1	310		···
	Supersoft ULX	M101 ULX-1	311		···
	Ultraluminous X-ray pulsar	M82 X-2	312		···
	Globular cluster ULX	RZ 2109 ULX	313		···
Indeterminate XRB	γ Cas	γ Cas	314		···
	Superfast X-ray transient	IGR J17544-2619	315		47
Outflow interaction binary	Colliding wind binary	WR 140	316		48
	Iron star	XX Oph	317		···
	Pulsar wind gamma-ray binary	PSR B1259-63	318		···
Spider pulsar	Black widow	PSR B1957+20	319		···
	Redback	PSR J1023+0038	300		49
	Huntsman	PSR J1417-4402	320		···
		Stellar group			
Detached binaries	Star-star	α Cen AB	321		···
	Multiple young stellar object	T Tau	322		···
	Brown dwarf-brown dwarf	Luhman 16	323		···
	White dwarf-white dwarf	WD 0135-052	324		···
	Neutron star-planet mass remnant	PSR J1719-1438	325		···
	Neutron star-white dwarf	PSR J0437-4715	272		···
	Neutron star-neutron star	PSR B1913+16	326		···
	Post common envelope	HW Vir	327		50
	Heartbeat binary	KOI 54	328		···
	Eclipsing binary star	YY Gem	329		···
	Eclipsing disk	ϵ Aur	330		···
	Eclipsing binary pulsar	PSR J0737-3039	331		···
	Self-lensing binary	KIC 8145411	332		···
	Chromospherically active binary	RS CVn	333		51
Open star cluster	Young	IC 2391	334		···
	Old	M67	335		···

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
Super star cluster		Westerlund 1	336		···
Faint fuzzy		N1023-FF-14	337		···
Globular cluster	Bulge-disk	47 Tuc	338		52
	Young halo	M15	339		···
	Old halo	NGC 6752	340		52
	Core-cusp	M15	339		···
	Extended	M31-EC4	341		···
	Ultrafaint	Palomar 1	342		···
Nuclear cluster		Central Cluster	343		···
	Stripped nucleus	ω Cen	344		···
R association		CMa R1	345		···
OB association	Compact	Cyg OB2	346		53
	Scaled	NGC 604	347		···
	Jet induced	Cen A outer filament	348		···
		ISM			
Diffuse molecular cloud	Translucent sightline	ζ Oph cloud	349		54
	Photodissociation region	NGC 7023	350		···
Dark molecular cloud	Giant molecular cloud	Orion A	351		55
	Infrared dark cloud	G028.37+00.07	352		···
	Dark cloud	TMC-1	353		56
	Starless core	Barnard 68	354		57
	Hot core	Orion hot core	355		58
	Reflection nebula	NGC 7023	350		···
HI supershell		Sextans A hole	356		···
Star-forming HII regions	Classical HII region	M42	357		···
	Ultracompact	W3(OH)	358		59
	Giant	NGC 3603	359		···
Star-formation maser regions	Maser HII region	W3(OH)	358		60
	OH megamaser	Arp 220	360		···
Protostellar outflow	Herbig-Haro Object	HH 1	361		61
	Extended Green Object	EGO G16.59-0.05	362		···
Stellar bowshock nebula		ζ Oph bow shock	363		62
Proto-planetary nebula		Red Rectangle nebula	364		···
Planetary nebula	Elliptical	Helix Nebula	365		···
	Bipolar/multipolar	NGC 6302	366		···
	Binary nucleus	NGC 2346	367		···
Massive star ejecta	Post-RSG shell	IRC +10420	368		···
	BSG hourglass nebula	SBW 1	369		···
	LBV shell	Homunculus Nebula	370		···
	Wolf-Rayet bubble	S 308	371		···
Supernova remnant	Shell	Cas A	372		···
	Composite	Kes 75	373		63
	Mixed-morphology	W44	374		64
	Young	SN 1987A	375		···
	OH maser	W44	374		···
Pulsar wind nebula	Plerion	Crab Nebula	376		···
	Magnetar wind nebula	SWIFT J1834.9-0846 nebula	377		···
	Bow shock	PSR B1957+20 bow shock	378		···
	TeV halo	Geminga halo	379		···
Symbiotic nebula		R Aqr nebula	380		···
Nova remnant		GK Per shell	381		···
SSS nebula		CAL 83 nebula	382		···
XRB nebula	X-ray binary bow shock nebula	SAX J1712.6-3739 nebula	383		···

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	X-ray binary bubble	Cygnus X-1 shell	384		· · ·
	X-ray ionized X-ray binary nebula	N159F	385		· · ·
	ULX nebula	W50	386		65
Nonthermal bubble	Cosmic ray cocoon	Cygnus Cocoon	387		· · ·
Circumgalactic medium	Compact high velocity cloud	HVC 125+41-208	388		66
	Lyman α blob	SSA22a-LAB01	389		· · ·
		Galaxy			
Quiescent (Red)	cD	NGC 6166	390		67
	Boxy/cored elliptical	NGC 4636	391		· · ·
	Disky/coreless elliptical	M59	392		· · ·
	Field elliptical	NGC 821	393		· · ·
	Lenticular	NGC 3115	394		· · ·
	Passive spiral	NGC 4260	395		· · ·
	Compact elliptical	M32	396		68
	UltraCompact Dwarf	NGC 4546 UCD-1	397		· · ·
	Dwarf elliptical	NGC 205	398		· · ·
	Dwarf spheroidal	Sculptor dSph	399		· · ·
	Ultrafaint dwarf	UMa II	400		· · ·
	Dwarf S0	NGC 4431	401		· · ·
	Relic red nugget	NGC 1277	402		· · ·
	Red nugget	MRG-M0150	403		· · ·
	Large quiescent (high-z)	MRG-M0138	404		· · ·
Green Valley	Post-starburst	IC 976	405		· · ·
	Extended star-formation	NGC 404	406		· · ·
	Sa-Sab spiral	M81	407		· · ·
	Sb-Sbc spiral	M100	408		· · ·
	Dwarf Sa-Sb spiral	D563-4	409		· · ·
	Edge-on Sa-Sb spiral	NGC 891	410		69
	Dwarf transitional	Phoenix dwarf	411		70
Main sequence (blue)	Star-forming elliptical	NGC 5173	412		· · ·
	Blue cored dwarf elliptical	IC 225	413		· · ·
	Sc-Scd spiral	M101	414		· · ·
	Sd-Sdm spiral	NGC 300	415		· · ·
	Sm spiral	NGC 55	416		· · ·
	Dwarf Sc-Sd spiral	NGC 4701	417		· · ·
	Super spiral	SS 16	418		· · ·
	Cluster late spiral	M99	419		· · ·
	Edge-on late spiral	NGC 4631	420		· · ·
	Irregular (dE/Magellanic-size)	NGC 6822	421		· · ·
	Irregular (dSph-size)	IC 1613	422		· · ·
	Amorphous (MS)	NGC 3077	423		· · ·
	LIRG ($z \sim 1$)	SGAS J143845.1+145407	424		· · ·
	Spiral galaxy (z $\sim$ 1.5)	Sp1149 (A1)	425		· · ·
	BzK-type ULIRG (z $\sim$ 1.5)	A68-HLS115	426		· · ·
	Submillimeter galaxy (MS, high-z)	HLock-01 (R)	427		· · ·
Starburst	Infrared-transparent nuclear	M82	428		71
	Blackbody nuclear	Arp 220	360		72
	Lyman Break Analog	Arp 236	429		· · ·
	BzK analog ($z \sim 0$)	HIZOA J0836-43	430		· · ·
	Blue compact dwarf	I Zwicky 18	431		· · ·
	Ultracompact blue dwarf	POX 186	432		· · ·
	Lyman α Emitter ($z \sim 0$)	Haro 2	433		73
	Green pea	NGC 2366	434		· · ·

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	Dwarf starburst ($z \sim 3$)	ID11	435		···
	Lyman α Emitter (SB, $z \sim 2$)	SL2S J02176-0513	436		···
	Lyman Break Galaxy (SB, $z \sim 3$)	cB 58	437		···
	Submillimeter galaxy (SB, high-z)	SMM J2135-0102	438		···
	Jet induced starburst	Minkowski's Object	439		74
Low surface brightness	Giant	Malin 1	440		75
	Red UltraDiffuse Galaxy	VCC 1287	441		···
	Blue UltraDiffuse Galaxy	UGC 2162	442		···
	Almost dark	HI 1232+20	443		···
Disturbed	Collisional ring	Cartwheel galaxy	444		76
	Polar ring	NGC 4650A	445		77
	Hoag-like ring	Hoag's Object	446		78
	Interacting	M51a/b	447		···
	Major merger	The Antennae	448		79
	Tidal dwarf	Antennae TDG	449		···
	Dumbbell galaxy	3C 75	450		···
	Jellyfish	ESO 137-001	451		80
	Fireball tail	IC 3418	452		···
Morphological subtypes	Grand design spiral	M51a	453		···
	Flocculent spiral	NGC 7793	454		81
	Leading spiral arms	NGC 4622	455		···
	Anemic spiral	M91	456		82
	Nuclear ring morphology	NGC 1097	457		B15
	Nuclear lens morphology	M64	458		···
	Double bar (nuclear bar) morphology	NGC 1291	459		B15
	Barlens morphology	NGC 2787	460		B15
	Strong bar morphology	NGC 1365	461		B15
	x_1 ring morphology	NGC 6012	462		B15
	Inner ring morphology	NGC 1433	463		B15, 83
	Plume morphology	NGC 1433	463		B15, 83
	Outer lens morphology	NGC 2787	460		B15
	Outer pseudoring morphology	NGC 1365	461		B15
	Outer Lindblad ring	NGC 5101	464		B15
	Double outer ring	NGC 3898	465		B15
	Counterrotating disks	M64	458		···
	Superthin disk	UGC 7321	466		84
	Shell galaxy	NGC 3923	467		···
	Rectangular galaxy	LEDA 074886	468		···
Environmental classification	Void galaxy	KK 246	469		···
	Brightest cluster galaxy	NGC 6166	390		···
	Satellite galaxy	NGC 205	398		···
		AGN			
Intermediate Mass BH	Hyperluminous X-ray source	ESO 243-49 HLX1	470		···
Low luminosity	Quiescent	Sgr A*	471		···
	LINER (AGN-powered)	NGC 1052	472		85
	Dwarf Seyfert	NGC 4395	473		···
XBONG		NGC 4686	474		···
Seyfert	Seyfert 1	NGC 7469	475		···
	Seyfert 2	NGC 1068	476		···
	Starburst/Seyfert composite	NGC 1068	476		···
	Narrow line Seyfert 1	I Zwicky 1	477		86
Radio galaxy	FR 0	NGC 2911	478		···
	FR I	Centaurus A	479		87

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
	FR II	Cygnus A	480		88
	Head-tail radio galaxy	NGC 1265	481		89
	X-shaped radio galaxy	3C 403	482		90
	Compact Steep Spectrum	3C 286	483		···
	GHz Peaked Source	PKS 1934-638	484		91
Quasar	Radio loud	3C 273	485		···
	Radio quiet	Mrk 335	486		···
	Broad Absorption Line	Cloverleaf quasar	487		···
	Weak line	PHL 1811	488		···
Blazar	BL Lac	BL Lac	489		···
	Flat Spectrum Radio Quasar (blazar)	3C 279	490		···
	Neutrino blazar	TXS 0506+056	491		···
Dust-obscured galaxy (AGN)	Power-law DOG	SST24 J143644.2+350627	492		···
	Hot DOG	WISE 1814+3412	493		···
Water megamaser AGN	Disk megamaser	NGC 4258	494		92
	Jet-driven megamaser	NGC 1052	472		···
Changing look	Optical	NGC 4151	495		···
	X-ray	NGC 1365	461		···
Offset	Wandering	ESO 243-49 HLX1	470		···
Multiple AGN	Dual AGN	NGC 6240	496		···
	Binary AGN	0402+379	497		···
	Interacting SMBH binary	OJ 287	498		···
	Merging jets dual AGN	3C 75	450		···
Remnant	Voorwerp	Hanny's Voorwerp	499		···
	Radio fossil	B2 0924+30	500		93
		Galaxy association			
Binary galaxy		Arp 294	501		···
Dwarf galaxy association		UGCA 319/320	502		···
Galaxy group	Compact	Stephan's Quintet	503		94
	Fossil	NGC 6482	504		···
	Galaxy interaction shock	Stephan's Quintet	503		···
Galaxy cluster	Regular	Fornax Cluster	505		···
	Irregular	Virgo Cluster	506		···
	Poor	Fornax Cluster	505		···
	Rich	Coma Cluster	507		···
	Cool core	Perseus Cluster	508		95
	Merging	Bullet Cluster	509		···
Protocluster		SSA22	510		···
Intracluster medium	Cold front	Abell 3667	511		···
	Shock front	Bullet Cluster	509		96
	X-ray cavities	Perseus Cluster	508		···
Nonthermal ICM	Giant radio halo	Coma C	512		97
	Radio minihalo	NGC 1275 minihalo	513		98
	Radio relic	1253+275	514		98
		LSS			
Intergalactic medium	Giant HI ring	Leo Ring	515		···
Gravitational basin	Attractor	Laniakea (Great) attractor	516		···
	Repeller	Dipole repeller	517		···
		Technology			

Table A1 *continued*

Table A1 *(continued)*

Type	Subtype	Prototype	ID	Solar?	Ref
~~Space station~~	~~Space station~~	~~International Space Station~~	~~518~~	✓	···
Satellite	Navigation satellite	TBD	519	✓	···
	Communications satellite	TBD	520	✓	···
	Amateur radio satellite	TBD	521	✓	···
	Earth observation radar satellite	TBD	522	✓	···
	Weather satellite	TBD	523	✓	···
	Space telescope	TBD	524	✓	···
Spacecraft	Space probe	*Voyager 1*	525	✓	···
	Solar sail	*LightSail 2*	526	✓	···
Passive structure	Radar calibration target	Lincoln Calibration Sphere-1	527	✓	···
Space debris	Derelict satellite	Vanguard I	528	✓	···
	Rocket booster	TBD	529	✓	···
	Dipole clump	1963-014G	530	✓	···
	NaK coolant droplets	Cosmos 860 coolant (1976-103G)	531	✓	···
	Car	Tesla Roadster	532	✓	···
		Not real			
Solar System		Solar antipoint	533	✓	···
	Earth-moon stable Lagrange point	Earth-Moon L_5	534	✓	···
	Earth-sun stable Lagrange point	Earth-Sun L_4	535	✓	···
Galactic	Galactic anticenter	Galactic anticenter	536		···

Note—**Prototype** – TBD refers to a type of technological object type whose Prototype is yet to be selected.
Solar? – ✓ if object is in or passed through Solar System and listed in Table E1; otherwise listed in Table E2.
Ref – Reference where stated to be "prototype", standard, or a representative example; see Catalog Notes for justification of other sources.

References—(B15) Buta et al. (2015); (K91) Kirkpatrick et al. (1991); (G94) Garrison (1994); (MK73) Morgan & Keenan (1973); (H15) Heiter et al. (2015); (B02) Bus & Binzel (2002); (T84) Tholen (1984); (1) Cochran et al. (2015, 2020); (2) Jewitt (2005); (3) Jewitt et al. (2009); (4) Jewitt (2009); (5) Meng et al. (2015); (6) Ridden-Harper et al. (2018); (7) Aurière et al. (2014); (8) Tannirkulam et al. (2008); Hashimoto et al. (2011); (9) Reipurth & Aspin (2004); Beck & Aspin (2012); Pérez et al. (2020); (10) Kirkpatrick (2005); Burgasser et al. (2006); (11) Dupuy et al. (2009); (12) Cruz et al. (2018); (13) Cushing et al. (2005); (14) Walborn et al. (2002); (15) Witt et al. (2009); (16) Chesneau et al. (2014); (17) Montez et al. (2015); (18) Morris et al. (2004); (19) Groh et al. (2009); (20) Humphreys et al. (1999); Massey et al. (2007); (21) Kochukhov & Wade (2010); (22) Sokoloski & Bildsten (2010); Wong et al. (2016); (23) Gautschy (2009); Richardson et al. (2011); (24) Kaye et al. (1999); (25) Green et al. (2003); Kilkenny et al. (2010); (26) Kilkenny et al. (1997, 2010); (27) Kilkenny et al. (2010); (28) Haisch et al. (1991); (29) Harding et al. (2013); (30) Jeffery (2008); (31) Ahmad et al. (2004, 2007); (32) Jahn et al. (2007); (33) Raddi et al. (2019); (34) Gehrz et al. (1995); (35) Bohlin et al. (1995); Preval et al. (2013); (36) Provencal et al. (2009); (37) Abdo et al. (2009); (38) Soderhjelm (1980); Richards (1992); (39) Allen (1980); (40) Hachisu & Kato (2001); Shore et al. (2011); (41) Osaki (1996); Nelan & Bond (2013); (42) Osaki (1996); Neustroev et al. (2011); (43) Patterson et al. (2017); (44) Walter et al. (2015); (45) Oates et al. (2019); (46) McClintock et al. (2006); (47) Sidoli et al. (2008); Farinelli et al. (2012); (48) Marchenko et al. (2003); Dougherty et al. (2005); Pittard & Dougherty (2006); Monnier et al. (2011); (49) Roberts (2013); (50) Heber (2016); Baran et al. (2018); (51) Rodonò et al. (2001); Xiang et al. (2020); (52) Dinescu et al. (1999); (53) Massey & Thompson (1991); Knödlseder (2000); (54) Snow & McCall (2006); Liszt et al. (2009); (55) Großschedl et al. (2018); (56) Fuente et al. (2019); (57) Nielbock et al. (2012); (58) van Dishoeck & Blake (1998); Cazaux et al. (2003); Hernández-Hernández et al. (2014); (59) Hachisuka et al. (2006); (60) Elitzur (1992); (61) Reipurth & Bally (2001); (62) Kobulnicky et al. (2016); (63) Helfand et al. (2003); (64) Shelton et al. (2004); Castelletti et al. (2007); (65) Abolmasov (2011); (66) Faridani et al. (2014); (67) Morgan & Lesh (1965); Bertola et al. (1986); Bender et al. (2015); (68) Faber (1973); Bender et al. (1992); Graham (2002); Huxor et al. (2013); Norris et al. (2014); (69) Hughes et al. (2014); (70) Ferguson & Binggeli (1994); (71) Seaquist & Odegard (1991); O'Connell et al. (1995); Shopbell & Bland-Hawthorn (1998); Naylor et al. (2010); Leroy et al. (2015); (72) Smith et al. (1998); Wilson et al. (2014); Martín et al. (2016); (73) Otí-Floranes et al. (2012); (74) Elbaz et al. (2009); (75) Barth (2007); Lelli et al. (2010); Boissier et al. (2016); (76) Appleton & Marston (1997); Parker et al. (2015); (77) Iodice et al. (2002); Karataeva et al. (2004); (78) Finkelman et al. (2011); (79) Mirabel et al. (1992); Whitmore et al. (2010); (80) Fumagalli et al. (2014); Fossati et al. (2016); (81) Elmegreen & Elmegreen (1982); (82) van den Bergh (1976); (83) Buta (1984); (84) Banerjee & Jog (2013); (85) Pogge et al. (2000); Sugai & Malkan (2000); Kadler et al. (2004); Ho (2008); (86) Huang et al. (2019); (87) Israel (1998); (88) Begelman et al. (1984); Perley et al. (1984); (89) Begelman et al. (1984); (90) Gopal-Krishna et al. (2012); (91) O'Dea (1998); (92) Lo (2005); (93) Jamrozy et al. (2004); (94) Duc et al. (2018); (95) Edge (2001); Nagai et al. (2019); (96) Markevitch et al. (2002); (97) Giovannini et al. (1991); Burns et al. (1992); Thierbach et al. (2003); Ferrari et al. (2008); Feretti et al. (2012); Brunetti & Jones (2014); van Weeren et al. (2019); (98) Feretti et al. (2012); van Weeren et al. (2019)

Table A2. Properties of transient phenomena

Phylum	Type	Example host	Host ID	Duration	Recurrence	Emission	Ref
		Periodic and predictable transients					

Table A2 *continued*

Table A2 *(continued)*

Phylum	Type	Example host	Host ID	Duration	Recurrence	Emission	Ref
Minor body	Periodic comets	1P/Halley	032	Weeks–Months	Years–Centuries	O	
	Stellar occultation	···	···	Milliseconds–Minutes	Infrequent	O	
Solid planetoid	Total solar eclipse	Sun/Moon	150, 101	Minutes	Decades	O	
	Lunar eclipse	Moon	101	Hours	Months	O	
	Lunar/planetary occultation (ingress/egress)	Moon/Aldebaran	101, 168	Milliseconds	Infrequent	O	
Star	Ultracool pulsar pulse	TVLM 513-46546	227	Minutes	Hours	R	1
	mCP pulsar pulse	CU Vir	228	Minutes	Day	R	2
Collapsed star	Pulsar pulse	Crab Pulsar	266	Milliseconds	Milliseconds–Seconds	RIOXγ	3
Interacting binary stars	CV pulsar pulse	AR Sco	291	Minute	Minutes	RIOUX	4
Stellar group	Binary eclipse	YY Gem	329	$\gtrsim$Minutes	$\gtrsim$Minutes	O	5
	Disk-star eclipse	ϵ Aur	330	Years	Decades	OI	6
Active galactic nucleus	Binary SMBH flare	OJ 287	498	Days	Years	O	7
	Quasiperiodic eruption	GSN 069	727	Hour	Hours	O	8
Anomaly	Periodic FRB	FRB 180916.J0158+65	750	Milliseconds	Hours	R	9
			Unpredictable repeating transients with known hosts				
Minor bodies	Dipper (UXOr) event	EPIC 203937317	070	Day–Months	$\geq$Days	O	10
Solid planetoid	Lightning	Earth	···	Milliseconds	Minutes	RO	
Stars	Yellow hypergiant eruption	ρ Cas	196	Years	Decades	O	11
	LBV giant eruption	η Car	203	Years	Centuries	IO	12
	R CrB dip	R CrB	233	Weeks	Years	O	13
	M dwarf flare	UV Cet	225	Minutes–Hours	Multiscale	ROUX	14
	Solar radio bursts	Sun	150	Milliseconds–Hours	Multiscale	R	15
	Superflare	κ_1 Cet	149	Minutes–Hours	Centuries	ROUX	16
	RS CVn-type star flares	HR 1099	226	Hours–Days	Day-Week	RUX	17
Collapsed star	Pulsar nanoshots	Crab Pulsar	266	Nanoseconds	Frequent	R	18
	Giant pulse	Crab Pulsar	266	Milliseconds	Minutes	R	19
	Magnetar flares	SGR 1806-20	267	Seconds–Minutes	Years	Xγ	20
	Magnetar afterglow	SGR 1806-20	267	Week	Years	R	21
	RRAT	PSR B0656+14	270	Milliseconds	Minutes–Hours	R	22
Interacting binary stars	Symbiotic slow nova	RR Tel	282	Decades	>Decades	O	23
	Symbiotic recurrent nova	RS Oph	283	Weeks	Decades	Oγ	24
	Dwarf nova	SS Cyg	284	Days–Weeks	Weeks–Years	O	25
	Anti-dwarf nova	MV Lyr	···	$\leq$Years	$\gtrsim$Months	O	26
	Recurrent nova (CV)	T Pyx	286	Week–Months	Decades	ROX	27
	Type I X-ray burst	4U 1608-52	295	Seconds–Minutes	Minutes–Hours	X	28
	Type II X-ray burst	4U 1730-335	296	Seconds	Seconds–Hour	X	29
	X-ray nova	V404 Cyg	306	Minutes	Multiscale	OXγ	30
	Supergiant fast X-ray transient	IGR J17544-2619	315	Hours–Days	Months–Year	X	31
	Plasma lensed pulsar pulse	PSR B1957+20	319	Seconds	Hours	R	32
ISM	Maser flare	W49N	620	$\gtrsim$ Days	Multiscale	R	33
	Pulsar wind nebula flare	Crab Nebula	376	Days	Months	γ	34
Active galactic nucleus	Quiescent flares	Sgr A*	471	Minutes–Hours	Hours–Days	RIX	35
	Extreme γ-ray blazar flare	3C 279	490	Hours–Days	Months	Xγ	36

Table A2 *continued*

Table A2 *(continued)*

Phylum	Type	Example host	Host ID	Duration	Recurrence	Emission	Ref
	Neutrino blazar flare	TXS 0506+056	491	Months	Years	ν	37
Anomaly	Radio burster	GCRT J1745-3009	748	Minutes–Hour	$\gtrsim$Hour	R	38
	Repeating FRB	FRB 121102	733	Milliseconds	Minute–Hours	R	39
Transients that occur once or very rarely per object, or with unknown recurrence							
Minor bodies	Meteor	···	···	Seconds	···	RO	
	Giant comet eruption	17P/Holmes	675	Weeks	···	O	40
	Hyperbolic comet	2I/Borisov	067	Weeks–Months	···	O	41
Stars	FU Ori outburst	FU Ori	132	Years–Century	···	O	42
	Final flash	V4334 Sgr	179	Years	···	O	43
	Microlensing event	···	··· [1]	Days	···	O	44
Collapsed star	Core collapse neutrino flash	SN 1987A	592	Seconds	···	ν	45
	Supernova shock breakout	XRT080109	···	Minutes–Hours	···	OX	46
	Core collapse supernova	SN 1987A	375	Weeks	···	OUX	47
	Radio supernova	SN 1993J	··· [2]	Weeks–Months	···	R	48
	Superluminous Supernova Type I	SN 2005ap	···	Weeks	···	O	49
	Superluminous Supernova Type II	SN 2006gy	···	Months	···	OX	50
	Failed supernova	NGC 6946-BH 1	275	~Year	···	O	51
	Long-soft GRB	GRB 030329	···	Seconds	···	Xγ	52
	GRB X-ray flare	GRB 050502B	···	Minutes	···	X	53
	Long-soft GRB afterglow	GRB 030329	···	Hours–Days	···	RIOUX	54
	Magnetar FRB	SGR 1935+2154	269	Milliseconds	···	R	55
Interacting binary stars	Luminous red nova	V838 Mon	230	Weeks–Months	···	IO	56
	Nova	GK Per	287	Weeks	>Decades	RIOUXγ	57
	Nova supersoft X-ray phase	V1974 Cyg (1992)	···	Year	···	X	58
	Type Ia supernova	SN 2014j	··· [3]	Weeks	···	IOU	59
	Type Iax supernova	SN 2002cx	···	Weeks	···	O	60
	Type .Ia supernova	SN 2010X	···	Days	···	O	61
	Neutron star merger (short-hard GRB)	GW170817	···	Milliseconds–Second	···	$\gamma\mathcal{G}$	62
	Kilonova	GW170817	···	Days	···	IOU	63
	Black hole merger	GW150914	···	Seconds	···	$\mathcal{G}$	64
ISM	Extreme scattering event	QSO 0954+658 sightline	···	Months	···	R	65
AGN	Tidal disruption event	TDE1	···	Months	Millennia	OU	66
		NGC 5905	···	Months	Millennia	X	67
	Jetted tidal disruption event	Swift J164449.31573451	···	Days	Millennia	RIOXγ	68
	Optical spike	Spikey	725	Days	Years?	O	69
Anomaly	Unexplained radio transients	RT 19920826	747[4]	Seconds–Decades	···	R	70
	Unexplained infrared transient	VVV-WIT-002	751	Months?	···	I	71
	Intermediate luminosity red transient	SN 2008S	756	Months	···	IOU	72
	Ca-rich gap transient	PTF 09dav	757	Week	···	O	73
	Fast blue optical transients	AT 2018cow	758[5]	Days	···	RIOUX	74
	ASASSN -15lh	ASASSN -15lh	693	Years	···	OUX	75
	Unexplained very fast X-ray transients	XRT 000519	760[6]	Minutes	···	X	76

Table A2 *continued*

Table A2 *(continued)*

Phylum	Type	Example host	Host ID	Duration	Recurrence	Emission	Ref
	Ultraluminous X-ray transients	CXOU J124839.0-054750	762[7]	Hours–Years	···	X	77
	Galactic long-soft gamma-ray transient	Swift J195509.6+261406	764	Seconds	···	Oγ	78
			Ubiquitous transients				
ISM	Cosmic ray shower	···	···	Nanoseconds	Ubiquitous	ROγei	
Technology	Radio frequency interference	···	···	Minutes	Ubiquitous	R	
	Satellite glints	···	···	Milliseconds–Seconds	Frequent	O	79

Note—**Duration** – Order-of-magnitude timescale for rise and fall of transient.
Recurrence – Order-of-magnitude time between transients emitted by host.
Emission – R: radio; I: infrared; O: optical; U: ultraviolet; X: X-rays; γ: gamma-rays; ν: neutrinos; $\mathcal{G}$: gravitational waves; e: high-energy electrons; i: high-energy ions.

[1] Microlensing of a star in the galaxy Sp1149 (A1) (425) by stars in a foreground lens galaxy has been observed.

[2] The host galaxy of SN 1993J is M81 (407).

[3] The host galaxy of SN 2014j is M82 (428).

[4] For additional examples, 740–745.

[5] See also Dougie (759).

[6] See also CDF-S XT1 (761).

[7] See also M86 tULX-1 (763).

References—(1) Hallinan et al. (2007, 2008); (2) Kellett et al. (2007); Das et al. (2019); (3) Hankins & Eilek (2007); Caraveo (2014); (4) Marsh et al. (2016); Takata et al. (2018); (5) Torres & Ribas (2002); (6) Hoard et al. (2010); (7) Dey et al. (2019); (8) Miniutti et al. (2019); (9) Chime/FRB Collaboration et al. (2020); (10) Herbst & Shevchenko (1999); Ansdell et al. (2016, 2020); (11) Lobel et al. (2003); (12) Humphreys & Davidson (1994); Smith et al. (2011); (13) Clayton (1996); (14) Haisch et al. (1991); Osten et al. (2005); Hilton et al. (2010); (15) Dulk (1985); (16) Schaefer et al. (2000); (17) White et al. (1978); Feldman et al. (1978); Osten & Brown (1999); (18) Hankins et al. (2003); (19) Lundgren et al. (1995); (20) Hurley et al. (2005); Boggs et al. (2007); (21) Gaensler et al. (2005); (22) McLaughlin et al. (2006); Weltevrede et al. (2006); (23) Kenyon & Truran (1983); (24) Schaefer (2010); Abdo et al. (2010); (25) Smak (1984); (26) Leach et al. (1999); Honeycutt & Kafka (2004); (27) Schaefer (2010); Nelson et al. (2014); (28) Galloway et al. (2008); (29) Lewin et al. (1993); (30) Tanaka & Shibazaki (1996); (31) Sguera et al. (2006); (32) Main et al. (2018); (33) Liljestrom et al. (1989); (34) Abdo et al. (2011); Tavani et al. (2011); (35) Marrone et al. (2008); (36) Wehrle et al. (1998); (37) IceCube Collaboration et al. (2018a); (38) Hyman et al. (2005); (39) Spitler et al. (2016); (40) Montalto et al. (2008); Reach et al. (2010); Hsieh et al. (2010); (41) Guzik et al. (2020); (42) Hartmann & Kenyon (1996); (43) Duerbeck & Benetti (1996); Clayton et al. (2006); (44) Kelly et al. (2018); (45) Arnett et al. (1989); (46) Modjaz et al. (2009); Bersten et al. (2018); (47) Arnett et al. (1989); (48) Fransson & Björnsson (1998); (49) Quimby et al. (2007); Gal-Yam (2012); (50) Ofek et al. (2007); Gal-Yam (2012); (51) Gerke et al. (2015); (52) Gehrels et al. (2009); (53) Burrows et al. (2005); (54) Gehrels et al. (2009); (55) Scholz & Chime/Frb Collaboration (2020); Bochenek et al. (2020); (56) Munari et al. (2002); (57) Seaquist et al. (1980); Hachisu & Kato (2006); Ackermann et al. (2014); (58) Krautter et al. (1996); (59) Goobar et al. (2014); Margutti et al. (2014); (60) Foley et al. (2013); (61) Shen et al. (2010); (62) Berger (2014); Abbott et al. (2017); (63) Cowperthwaite et al. (2017); (64) Abbott et al. (2016); (65) Fiedler et al. (1987); (66) van Velzen et al. (2011); (67) Bade et al. (1996); (68) Bloom et al. (2011); (69) Smith et al. (2018); (70) Bower et al. (2007); Frail et al. (2012); (71) Dekany et al. (2014); (72) Prieto et al. (2008); (73) Sullivan et al. (2011); Kasliwal et al. (2012); (74) Drout et al. (2014); Prentice et al. (2018); (75) Dong et al. (2016); Leloudas et al. (2016); (76) Jonker et al. (2013); (77) Sivakoff et al. (2005); (78) Kasliwal et al. (2008); Stefanescu et al. (2008); Castro-Tirado et al. (2008); (79) Maley (1987); Schaefer et al. (1987)

B. THE SUPERLATIVE SAMPLE

All objects in the Superlative sample, with their relevant properties, are listed in Table B1.

Table B1. Superlative sample

Type	Property	Value	Superlative	ID	Solar?	True?	Ref
			Minor body				
All minor bodies	α_G^V (darkest)	$0.027^{+0.006}_{-0.007}$	1173 Anchises	537	✓	✓	1
	α_G^V (brightest)	$0.76^{+0.18}_{0.45}$–$0.88^{+0.15}_{-0.06}$	(55636) 2002 TX_{300}	538	✓	✓	2

Table B1 *continued*

Table B1 *(continued)*

Type	Property	Value	Superlative	ID	Solar?	True?	Ref
	M_{host} (smallest)	8^{+7}_{-3} M_J	Cha 110913-773444	539		?	3
Interplanetary minor bodies	a (closest)	0.5553 ± 0.0002 AU	2019 LF_6	540	✓	✗/S?	4
	Q (closest)	0.65377 ± 0.00012 AU	2020 AV_2	016	✓	✗/S?	5
	q (furthest)	80.40 ± 0.09 AU	2012 VP_{113}	541	✓	✗	6
		65.2 ± 0.2 AU	541132 Leleākūhonua	052	✓	✗	···
Minor satellites	R (largest)	210 ± 7 km	Proteus	542	✓	✓	7
	a (closest, planet host)	9.376 Mm	Phobos	053	✓	✗/S	···
	a (furthest)	50 Gm	Neso	543	✓	S	···
	a/R_p (smallest)	1.79	Metis	544	✓	✓	···
Planetary rings	M_{host} (smallest)	$\sim 8 \times 10^{-7}$ $M_\oplus$	2060 Chiron	039	✓	?	8
	M_{host} (largest)	$\sim$ 14–26 M_J	1SWASP J140752.03-394415.1 b	545		?	9
	R (smallest)	324 km	2060 Chiron	039	✓	?	10
	R (largest)	$\sim$ 27 Gm	1SWASP J140752.03-394415.1 b	545		?	11
			Solid planetoid				
Solid planetoids	M (smallest)	6.3×10^{-6} $M_\oplus$	Mimas	546	✓	✓	···
	R (smallest)	198.2 ± 0.3 km	Mimas	546	✓	✓	···
	α_G (darkest)	0.05	Iapetus	547	✓	✓	···
		0.09	1 Ceres	095	✓	✓	···
	α_G (brightest)	1.3	Enceladus	107	✓	✓	···
Major satellites	M (largest)	0.0248 $M_\oplus$	Ganymede	106	✓	S	···
	R (largest)	2,631 km	Ganymede	106	✓	S	···
	ρ (lowest)	0.973 $g\,cm^{-3}$	Tethys	548	✓	✓?/S	···
	ρ (highest)	3.528 $g\,cm^{-3}$	Io	108	✓	✗?/S	···
	M_{moon}/M_{host} (smallest)	6.60×10^{-8}	Mimas	546	✓	✗/S	···
	M_{moon}/M_{host} (largest)	0.122	Charon	549	✓	✗?/S	12
	M_{moon}/M_{host} (largest, planet host)	0.0123	Moon	101	✓	✗?/S	···
	a (closest)	19.6 Mm	Charon	549	✓	✗/S?	13
	a (closest, planet)	129.9 Mm	Miranda	550	✓	✗/S	···
	a (furthest)	3.56 Gm	Iapetus	547	✓	✗?/S	···
Dwarf planets	M (smallest)	0.000157 $M_\oplus$	1 Ceres	095	✓	?	···
	M (largest)	0.0028 $M_\oplus$	136199 Eris	096	✓	S	14
	R (smallest)	469.7 km	1 Ceres	095	✓	?	15
	R (largest)	1,188.3 km	134340 Pluto	097	✓	S	16
	a (closest)	2.768 AU	1 Ceres	095	✓	✗/S	···
	a (furthest)	67.86 AU	136199 Eris	096	✓	✗	···
		484.4 AU	90377 Sedna	098	✓	✗	···
Solid major planets	M (smallest)	0.020 ± 0.002 $M_\oplus$	PSR 1257+12 A	094		✗	17
	M (smallest, non-PSR host)	$0.066^{+0.059}_{-0.037}$–(0.187 ± 0.050) $M_\oplus$	Kepler 138 b	551		✗	18
	R (smallest)	$0.303^{+0.053}_{-0.073}$ $R_\oplus$	Kepler 37 b	552		✗	19
	ρ (densest)	12.65 ± 2.49 $g\,cm^{-3}$	Kepler 107 c	553		✓	20
	α_G (brightest)	0.65	Venus	085	✓	✗?/S	···
	t (oldest)	11.0 ± 0.8 Gyr	Kepler 444	083		✓	21
		$\sim$ 12–13 Gyr	82 Eri	554		✓	22
	P (shortest)	4.25 hr	KOI 1843.03	555		?	23
	N_{planet} (most)	7	TRAPPIST-1	091		?	24
	M_{host} (smallest, star)	0.086 ± 0.008 $M_\odot$	TRAPPIST-1	091		✓	25

Table B1 *continued*

Table B1 *(continued)*

Type	Property	Value	Superlative	ID	Solar?	True?	Ref
			Giant planet				
Giant planets	R (biggest, $<$ 1 M_J)	$22.9^{+1.1}_{-0.8}$ $R_\oplus$	HAT-P-67 b	556		✓?	26
	ρ (lowest)	$0.034^{+0.069}_{-0.019}$ $g\,cm^{-3}$	Kepler 51 c	557		✓?	27
	T (hottest)	$4{,}050 \pm 180$ K	KELT 9 b	558		?	28
	α_G (darkest)	0.025–0.05	TrES-2 b	559		✓	29
	α_G (brightest)	0.52	Jupiter	113	✓	?	...
	t (youngest)	2 Myr	V830 Tau b	560		✓	30
	t (oldest)	11.2–12.7 Gyr	PSR B1620-26 (AB) b	124		✓	31
	M_{host} (largest)	2.8 $M_\odot$	κ And b	561		×	32
		1.6–3.2 $M_\odot$	o UMa b	562		×	33
	L_{host} (brightest)	~ 610 (500–730) $L_\odot$	HD 208527 b	563		×	34
	T_{host} (hottest)	$11{,}327^{+421}_{-44}$ K	κ And	561		×	35
		$10{,}170 \pm 450$ K	KELT 9 b	558		×	36
	a (furthest)	2,500 AU	GJ 3483 B	564		×	37
	a (furthest, $<$ 1 M_J)	137 AU	HD 163269 b	565		×	38
			Star				
Sub-brown dwarfs	T_{eff} (coldest)	225–260 K	WISE J085510.83-071442.5	133		×	39
Stars	M (largest)	265^{+80}_{-35}–315^{+60}_{-15} $M_\odot$	R136 a1	566		L	40
	L (faintest)	0.00013 $L_\odot$	2MASS J0523-1403	142		✓	41
	L (brightest)	$8.7^{+2.0}_{-1.6} \times 10^6$ $M_\odot$	R136 a1	566		L	42
	R (smallest)	$0.084^{+0.014}_{-0.004}$ $R_\odot$	EBLM J0555-57 Ab	567		✓	43
		0.086 ± 0.003 $R_\odot$	2MASS J0523-1403	142		✓	44
		0.11 $R_\odot$	Feige 34	568		✓	45
	R (largest)	5 – 13 AU	NML Cyg	569		✓	46
		8 ± 1 AU	UY Sct	570		✓	47
	ρ (densest)	~ 530 $g\,cm^{-3}$	Feige 34	568		✓	48
	T_{eff} (coldest)	$2{,}074 \pm 21$ K	2MASS J0523-1403	142		✓	49
	T_{eff} (hottest)	210,000 K	WR 102	200		✓	50
	t (oldest)	12–14 Gyr	HD 140283	213		✓	51
	[Fe/H] (poorest)	< -7.1	SMSS J0313-6708	571		×?	52
	[Fe/H] (richest)	~ 0.5	14 Her	572		?	53
	[C/H] (lowest)	< -4.3	SDSS J102915+172927	573		×?	54
	v (fastest)	$23{,}923 \pm 8{,}840$ $km\,s^{-1}$	S4711	574		×	55
	v (fastest, unbound)	$1{,}755 \pm 50$ $km\,s^{-1}$	S5-HVS1	575		R?	56
	P_{SMBH} (shortest)	7.6 ± 0.3 yr	S4711	574		×	57
	q_{SMBH} (closest)	12.6 ± 9.3 AU	S4711	574		×	58
			Collapsed star				
White dwarfs	M (smallest)	0.16 $M_\odot$	SDSS J222859.93+362359.6	576		?	59
		0.13–0.16 $M_\odot$	NLTT 11748	243		?	60
	M (largest)	1.36–1.37 $M_\odot$	U Sco	577		✓	61
	M (largest, non-interacting)	1.310–1.335 $M_\odot$	LHS 4033	578		✓	62
	T_{eff} (coldest)	$< 3{,}000$ K	PSR J2222-0137 B	579		?	63
	T_{eff} (hottest)	250,000 K	RX J0439.8-6809	580		✓	64
	B (strongest)	0.5–1 GG	PG 1031+234	581		?	65

Table B1 *continued*

Table B1 *(continued)*

Type	Property	Value	Superlative	ID	Solar?	True?	Ref
	t (oldest)	11.5 Gyr	WD 0346+246	582		✓	66
	v (fastest, inflated remnant)	$\sim$ 2,400 km s^{-1}	D6-3	250		?/R?	67
	$v_{\rm trans}$ (fastest)	$\sim$ 350 km s^{-1}	LP 400-22	583		×	68
Neutron stars	M (smallest)	1.02 ± 0.17 M$_\odot$	4U 1538-522	584		?	69
	M (largest)	$2.14^{+0.10}_{-0.09}$ M$_\odot$	MSP J0740+6620	585		?	70
		2.40 ± 0.12 M$_\odot$	PSR B1957+20	319		✓	71
	L$_{\rm rot}$ (brightest)	130,000 L$_\odot$	PSR J0537-6910	586		?	72
	L$_{\rm rot}$ (dimmest)	6.8×10^{-6} L$_\odot$	PSR J2144-3933	587		×	73
	T$_{\rm eff}$ (coldest)	$<$ 42,000 K	PSR J2144-3933	587		×	74
	P$_{\rm rot}$ (fastest)	0.89 ms	XTE J1739-285	588		✓	75
	P$_{\rm rot}$ (slowest)	$36{,}200 \pm 110$ s	AX J1910.7+0917	589		?	76
	B (weakest)	0.085–2 GG	IGR J00291+5934	590		?	77
	B (strongest)	0.2–2 PG	SGR 1806-20	267		?	78
		0.70 PG	SGR 1900+14	591		?	79
	t (youngest)	33 yr (2020)	NS 1987A	592		R/L	80
	$v_{\rm trans}$ (fastest)	$1{,}083^{+103}_{-90}$ km s^{-1}	PSR B1508+55	593		?	81
Radio pulsars	P$_{\rm rot}$ (fastest)	1.397 ms	PSR J1748-2446ad	594		✓	82
	P$_{\rm rot}$ (fastest, unrecycled)	16.11 ms	PSR J0537-6910	586		?	83
	P$_{\rm rot}$ (slowest)	23.5 s	PSR J0250+5854	595		?	84
Black holes	M (smallest)	$3.3^{+2.8}_{-0.7}$ M$_\odot$	2MASS J05215658+4359220	596		✓	85
			Interacting binary star				
Interacting binaries	P (shortest)	321.25 ± 0.25 s	HM Cnc	597		R	86
	EIRP (brightest)	$\sim (0.7\text{–}6) \times 10^7$ L$_\odot$	NGC 5907 ULX	598		?	87
			Stellar group				
Detached binaries	M (smallest)	$7.4^{+2.4}_{-1.8}$–$18.2^{+4.7}_{-3.8}$ M$_{\rm J}$	TWA 42	599		?	88
	M (largest)	266^{+38}_{-35} M$_\odot$	Melnick 34	600		L	89
	M$_2 \sin i$ (smallest)	0.76 M$_{\rm J}$	PSR J2322-2650	601		R?	90
	P (shortest)	414.79 s	ZTF J153932.16+502738.8	602		R	91
Detached multiples	N$_\star$ (most)	7	65 UMa	603		R?	92
	N$_{\rm tier}$ (most)	5	65 UMa	603		R?	93
Non-hierarchical stellar groups	ρ (highest)	$\gtrsim 10^8$ M$_\odot$ pc^{-3}	IRS 13E	604		?	94
Star clusters	M (largest)	$(8 \pm 2) \times 10^7$ M$_\odot$	NGC 7252 W3	605		R?	95
Open star clusters	$\rho_{1/2}$ (highest, MW)	$\sim$ 6,000 M$_\odot$ pc^{-3}	HD 97950	606		M	96
	t (oldest)	9–10 Gyr	Be 17	607		✓	97
	[Fe/H] (richest)	0.313 ± 0.005	NGC 6791	608		M	98
Globular clusters	M (largest, old)	8×10^6 M$_\odot$	G1	609		R/L	99
		$\leq 3 \times 10^7$ M$_\odot$	(GC) 037-B327	610		R/L	100
	ρ (highest)	$\sim 10^5$ M$_\odot$ pc^{-3}	M85-HCC 1	611		?	101
	M_V (dimmest)	0.7 ± 0.3	Kim 3	612		×?	102
	t (oldest)	$\sim$ 12.5–13.0 Gyr	NGC 6522	613		✓	103
	[Fe/H] (poorest)	$-2.48^{+0.06}_{-0.11}$	ESO 280-SC06	614		L	104
	[Fe/H] (richest)	$\sim -0.2\text{–}+0.2$	NGC 6528	615		M	105

Table B1 *continued*

Table B1 *(continued)*

Type	Property	Value	Superlative	ID	Solar?	True?	Ref
			ISM				
ISM	T (coldest)	0.3–2 K	Boomerang Nebula	616		✓	106
Giant molecular clouds	M (largest)	8×10^6 $M_\odot$	Sgr B2	617		M (R)	107
Hot cores	M (largest)	9,000 $M_\odot$	Sgr B2(N) AN01	618		M	108
HII regions	$L_{H\alpha}$ (brightest)	$(1.3–3.9) \times 10^6$ $L_\odot$	30 Dor	619		✗/L	109
	R (biggest)	~ 200 pc	NGC 604	347		✗/L	110
Maser regions	$EIRP_{H_2O}$ (brightest, Galactic)	~ 1 $L_\odot$	W49N	620		M (✗)	111
			Galaxy				
Galaxies	$M_{1/2}$ (smallest)	$< 1.5 \times 10^5$ $M_\odot$	Segue 2	621		✗	112
	$M_\star$ (smallest)	600^{+115}_{-105}–$1{,}300^{+200}_{-200}$ $M_\odot$	Segue 1	622		✗	113
	$M_\star$ (largest)	$(1–4) \times 10^{12}$ $L_\odot$	IC 1101	623		✓	114
		$(2–6) \times 10^{12}$ $L_\odot$	OGC 21	624		✓	115
	R_{max} (biggest)	610 kpc	IC 1101	623		✓	116
		960 kpc	LEDA 088678	625		✓	117
	R_{eff} (biggest)	$\lesssim 146–439$ kpc	IC 1101	623		✓	118
	Σ (largest)	9.4×10^{10} $M_\odot$ kpc^{-2}	M59-UCD3	626		✓	119
	$L_\star$ (faintest)	335^{+235}_{-185} $L_\odot$	Segue 1	622		✗	120
	$L_\star$ (brightest)	$(3.6 \pm 0.3) \times 10^{13}$ $L_\odot$	SPT 0346-52	627		✓	121
		$(4.9 \pm 1.0) \times 10^{13}$ $L_\odot$	WISE J101326.25+611220.1	628		✓	122
	μ_V (faintest)	31.9 mag $arcsec^{-2}$	Antlia 2	629		✗	123
	[Fe/H] (poorest)	-2.65 ± 0.07	Reticulum II	630		?	124
	z (furthest)	$11.09^{+0.08}_{-0.12}$	GN-z11	631		✗	125
		10.7–11.1	MACS0647-JD	632		✗	126
Quiescent galaxies	L_V (brightest)	1.1×10^{12} $L_\odot$	IC 1101	623		✓	127
	z (furthest)	3.717	ZF-COSMOS-20115	633		?	128
Star-forming galaxies	SFR (highest)	$3{,}600 \pm 300$ $M_\odot$ yr^{-1}	SPT 0346-52	627		✓	129
	R_{eff} (smallest)	$\sim 166 \pm 54$ pc	POX 186	432		?	130
	$M_{gas}/M_\star$	35–475	AGC 229385	634		✗?	131
	12 + log O/H (poorest)	6.98 ± 0.02	J0811+4730	635		R?	132
	12 + log O/H (richest)	8.54–9.21	NGC 2841	636		✓	133
	$EIRP_{OH}$ (brightest)	13,000 $L_\odot$	IRAS 14070+0525	637		✓	134
Spiral galaxies	$M_\star$ (largest)	$\sim 1.4 \times 10^{12}$ $M_\odot$	SS 14	638		✓?	135
	R_{max} (largest)	67 kpc	SS 03	639		✓?	136
	z (furthest)	2.54	A1689B11	640		?	137
Lensed galaxies	$\mathcal{M}$ (greatest)	$(60–65) \pm 20$	SPT-CLJ2344-4243 Arc	641		✓	138
		$\sim 80 \pm 10$	The Snake	642		✓	139
			AGN				
AGNs	M_{SMBH} (smallest)	5×10^4 $M_\odot$	RGG 118	643		?	140
	M_{SMBH} (largest)	$(4.0 \pm 0.8) \times 10^{10}$ $M_\odot$	Holm 15A	644		✓?	141
		$(4–10) \times 10^{10}$ $M_\odot$	IC 1101	623		✓?	142
	L (brightest)	8.5×10^{14} $L_\odot$	HS 1946+7658	645		✓	143
		6.95×10^{14} $L_\odot$	SMSS 2157-36	646		✓	144

Table B1 *continued*

Table B1 *(continued)*

Type	Property	Value	Superlative	ID	Solar?	True?	Ref
	L_{IR} (brightest)	$(1.2–3.6) \times 10^{14}$ $L_{\odot}$	WISE 2246-0526	647		✓	145
	$M_{\star host}$ (smallest)	$(1.2 \pm 0.4) \times 10^{8}$ $M_{\odot}$	M60-UCD1	648		×	146
		$\sim 2 \times 10^{8}$ $M_{\odot}$	J1329+3234	649		×	147
	$M_{SMBH}/M_{\star host}$ (largest)	$0.175^{+0.26}_{-0.088}$	M60-UCD1	648		?	148
	z (furthest)	7.54	J1342+0928	650		?	149
Lensed AGNs	$\mathcal{M}$ (greatest)	~ 173	CLASH B1938+666	651		✓?	150
		~ 159	COSMOS 5921+0638	652		✓?	151
Radio lobes	2R (largest)	4.7 Mpc	J1420-0545	653		✓	152
Water megamasers	$EIRP_{H_2O}$ (brightest)	23,000 $L_{\odot}$	J0804+3607	654		✓	153
			Galaxy association				
Galaxy groups	ρ (densest)	~ 2 $M_{\odot}$ pc^{-3}	HCG 54	655		✓?	154
		~ 0.3 $M_{\odot}$ pc^{-3}	Seyfert's Sextet	656		R?	155
Galaxy clusters	M (largest)	$(2.93^{+0.36}_{-0.32}–3.4^{+0.4}_{-0.4}) \times 10^{15}$ $M_{\odot}$	Abell 370	657		✓	156
	M (largest, $z > 0.5$)	$\sim (2.8 \pm 0.4) \times 10^{15}$ $M_{\odot}$	MACS J0717.5+34	658		✓	157
	$\mathcal{R}$ (richest)	5	Abell 665	659		✓	158
	L_X (brightest)	$2.14^{+0.03}_{-0.05} \times 10^{12}$ $L_{\odot}$	Phoenix Cluster	660		✓	159
	T_{ICM} (hottest)	14.2 ± 0.3 keV	Bullet Cluster	509		✓	160
	z (furthest, X-ray)	2.506	CL J1001+0220	661		✓?	161
Radio halos	$L_{1.4\ GHz}$ (brightest)	0.26–0.4 $L_{\odot}$ Hz^{-1}	MACS J0717.5+34	658		✓	162
Radio relics	$L_{1.4\ GHz}$ (brightest)	0.13 $L_{\odot}$ Hz^{-1}	MACS J0717.5+34	658		✓	163
Protoclusters	z (furthest)	8.38	A2744z8OD	662		?	164
			LSS				
Galaxy superclusters	M (largest)	$\sim (2–7) \times 10^{16}$ $M_{\odot}$	Shapley Supercluster	663		✓	165

Table B1 *continued*

Table B1 *(continued)*

Type	Property	Value	Superlative	ID	Solar?	True?	Ref

Note—**Quantities** – 12 + log O/H: abundance of oxygen relative to hydrogen; a: orbital semimajor axis; α_G: geometric albedo; α_G^V: geometric albedo (V-band); B: magnetic field strength; [C/H]: $\log_{10}$ abundance of carbon with respect to Solar composition; EIRP: effective isotropic radiation power; $\mathrm{EIRP_{H_2O}}$: EIRP of maser in water emission line; $\mathrm{EIRP_{OH}}$: EIRP of maser in OH emission line; [Fe/H]: $\log_{10}$ abundance of iron with respect to Solar composition; L: object luminosity; $\mathrm{L_{1.4\ GHz}}$: luminosity at 1.4 GHz; $\mathrm{L_{H\alpha}}$: luminosity of Hα emission line; $\mathrm{L_{host}}$: luminosity of host star; $\mathrm{L_{IR}}$: infrared luminosity; $\mathrm{L_{rot}}$: estimated spin-down power of pulsar; $\mathrm{L_V}$: luminosity in V-band; L_X: X-ray luminosity; M: object mass; $\mathrm{M_{1/2}}$: mass within half-light radius (including dark matter); $\mathrm{M_{SMBH}}$: mass of galaxy's central black hole; $\mathrm{M_{gas}}$: gas mass of galaxy; $\mathrm{M_{host}}$: mass of host galaxy; $\mathrm{M_{host}}$: mass of host star; $\mathrm{M_{host}}$: mass of host planet; $\mathrm{M_{moon}}$: mass of satellite; $\mathrm{M_2} \sin i$: minimum mass of secondary (less massive) object in system as determined by radial velocity method; $\mathrm{M_\star}$: stellar mass of galaxy; M_V: absolute magnitude in V-band; $\mathcal{M}$: magnification by gravitational lens; μ: surface brightness; N_{planet}: number of planets of given phylum in stellar system; $\mathrm{N_\star}$: number of stars in system; $\mathrm{N_{tier}}$: number of hierarchical levels in multiple star system; P: orbital period; P_{SMBH}: orbital period around host galaxy's central black hole; $\mathrm{P_{rot}}$: rotation period; q: pericenter; q_{SMBH}: pericenter of orbit around host galaxy's central black hole; Q: apocenter; R: object radius; $\mathrm{R_{eff}}$: effective (half-light) radius of system; R_p: radius of host planet; $\mathrm{R_{max}}$: full radius of entire object; $\mathcal{R}$: richness of galaxy cluster; ρ: density; $\rho_{1/2}$: density within half-mass radius; SFR: star-formation rate; t: age; T: object surface temperature; $\mathrm{T_{eff}}$: effective temperature; $\mathrm{T_{host}}$: effective temperature of host star; $\mathrm{T_{ICM}}$: temperature of intracluster medium; v: speed; v_{trans}: transverse velocity on Earth's sky (from proper motion); z: redshift.
Solar? – ✓ if object is in or passed through Solar System and listed in Table E1; otherwise listed in Table E2.
True? – Whether or not the listed object is thought to represent the actual limiting values in the population or instead merely the limits of our observational capabilities. ✓if the value listed is likely to be among the most extreme for that type of object; ✕ if the value listed is likely to be greatly superseded with further discoveries; R if the listed object is likely on the tail of the distribution but there are likely rare objects significantly more extreme; ? if it is unclear whether the value listed represents a true Superlative or merely observational biases; S if likely to be among the most extreme values in the Solar System only; M if likely to be among the most extreme values in the Milky Way only; L if likely to be among the most extreme values in the Local Group only. Justifications for the ratings are given in the full *Exotica Catalog* target notes.

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C. THE ANOMALY SAMPLE

All objects in the Anomaly sample are listed in Table C1 (if not a previous SETI candidate) and Table C2 (if a previous SETI candidate). Table C3 lists anomalies that were not included in the catalog for practical reasons.

Table C1. Anomaly (Non-SETI) sample

Type	Description	Anomaly	Class	ID	Solar?	Ref
		Class I				
Pulsar planets	Unknown formation mechanism, rare for PSR	PSR B1257+12	I (III)	094		1
Paradoxical ELM WDs	ELM white dwarf in too wide binary to be formed	KIC 8145411	0/I	332		2
		HE 0430-2457	0/I	664		3
Peripheral MSP binaries	MSP-WD binary unexpectedly at edge of globular	PSR J1911-5958A	I	665		4
	PSR-star binary at edge of globular cluster	PSR J1740-5340	I	666		5
Nuclear cluster stars	Stars in hostile Galactic Center environment, where tides could prevent star formation	S0-2	I	667		6
		IRS 16C	I	668		7
Nuclear subcluster	Apparent extremely dense star subcluster within inner parsec, possibly within tidal disruption limit	IRS 16E	I	604		8
Nuclear cluster clouds	Odd compact Galactic Center cloud	G2	I/IV	669		9
Displaced supernova	Core collapse supernova well beyond host galaxy's plane	ASASSN -14jb	0/I	670		10
	Core collapse supernova in distant outskirts of galaxy, far from star-forming regions	SN 2009ip	I	671		11
Hypervelocity globular cluster	Intergalactic globular cluster with peculiar velocity $\sim 1{,}000\ \mathrm{km\,s^{-1}}$	HVGC-1	0/I	672		12
Peculiar offset AGNs	AGNs with offsets in location and velocity from galactic center, possible recoiling SMBHs	3C 186	0/I	673		13
		SDSS J113323.97+550415.9	0/I/IV	674		14
		Class II				
Extreme comet outburst	Unexplained brightening by factor 10^6	17P/Holmes	0/II	675	✓	15
Underheated ice giant	Unexplained low heat flux	Uranus	0/II	676	✓	16
Super-puffs	Planets with unexplained, extremely low density	HIP 41378 f	II	677		17
Anomalous abundance star	Stars with as-yet unexplained depletions in iron-peak elements, presumably due to suppressed accretion of dust	λ Boo	0/II	207		18
	Abnormally high abundances of Re-Hg, Zr/Nb/Mo anomaly	HD 65949	II	678		19
	Unexplained rare-earth and radioactive elements	Przybylski's Star	II	679		20
	Abnormally high Be abundance	HD 106038	0/II	680		21
	Abnormally Mn-enhanced Ni-depleted metal-rich star	HD 135485	II	681		22

Table C1 *continued*

Table C1 *(continued)*

Type	Description	Anomaly	Class	ID	Solar?	Ref
	Star with abnormal abundances	LS IV-14 116	0/II	682		23
	Phosphorus-rich star with other abundance anomalies	2MASS J13535604+4437076	II	683		24
Anomalous red companion star	Abnormal red companion star to PSR with radius too large to fit in Roche Lobe	COM 6266B	II/V	684		25
Subsubgiant star	Stars redder than MS, below subgiant branch	M67-S1063	0/II	685		26
Red straggler	Star redder than red giant; unexplained companion to PSR	PSR J1740-5340	0/II	666		27
Bloatars	Luminous stars with $T \sim 2{,}000$ K	[SBD2011] 5	II	686		28
Kilosecond rotation magnetar	Magnetar with 7 hr rotation period	1E 1613-5055	II	687		29
Paradoxical WD binary	WD-WD binary, younger WD also the more massive one	DWD HS 2220+2146	0/II	688		30
Overmassive SMBH	SMBHs far too massive for host given known correlations	NGC 1277*	0/II	689		31
		Was 49b	II	690		32
Ultrapolarized radio source	Radio galaxy with anomalously high ($\gtrsim$ 30%) linear polarization	2MASX J07390433+1804252	0/II	691		33
	Resolved extragalactic radio source with extremely high linear polarization (54% at 8.87 GHz), possibly lensed galaxy	J 06587-5558	0/II	692		34
Hyperluminous SN/TDE	Abnormally bright TDE or possibly SLSN	ASASSN -15lh	0/II	693		35
CMB Cold Spot	Unusually extreme temperature fluctuation in CMB	CMB Cold Spot	II	694		36
		Class III				
Unusual spectrum asteroid	Asteroid with unusual spectrum in sparse region of MBA, no sign of parent collisional family	(10537) 1991 RY_{16}	0/III (+ I)	695	✓	37
Unexplained geology	Ridge encircles moon, formation unclear	Iapetus	0/III	547	✓	38
Anomalous interstellar object	Non-gravitational accelerations, claimed unusual shapes	1I/'Oumuamua	III+III	068	✓	39
Anomalous transiters	Deep aperiodic eclipses	Boyajian's Star	0/III	696		40
	Random transiter	HD 139139	III	697		41
	Mysterious eclipses	VVV-WIT-07	0/III	698		42
	Star with fading and brightening episodes	ASASSN-V J060000.76-310027.83	III	699		43
Anomalous spectrum star	Red dwarf with WD-like excess emission and Na absorption lines	WISEA 0615-1247	III	700		44
Anomalous variable star	Helium subdwarf star with unexplained variability	LS IV-14 116	III	682		45

Table C1 *continued*

Table C1 *(continued)*

Type	Description	Anomaly	Class	ID	Solar?	Ref
Anomalous non-variable star	Star apparently in Cepheid strip without significant photometric or RV variability	45 Dra	III	701		46
	Star nearly identical to Cepheid companion but lacking variability	OGLE LMC-CEP-4506	III	702		47
Anomalous dimming stars	Unexplained decadal variability	Boyajian's Star	III	696		48
	Young sun analog that has been fading for ∼50 yr	EK Dra	III	703		49
	Star dimmed by 1 magnitude over a few days	ASASSN-V J190917.06+182837.36	III	704		50
	Star dimmed by over 1 magnitude over a few days, then recovered rapidly	ASASSN-V J213939.3-702817.4	III	705		51
	Star dimmed by 1.5 mag over the course of a week	ASASSN V J193622.23+115244.1	III	706		52
Vanishing supergiants	Supergiant stars that have faded and disappeared, far below initial luminosity, possibly after minor outbursts	NGC 6946-BH1	0/III	275		53
		NGC 3021-CANDIDATE 1	0/III	707		54
Anomalous stellar outburst	Unexplained outburst with 10 sec rise and hour persistence in B giant	BW Vul	III	708		55
	Unexplained outburst/flare in B dwarf	BD +31°1048	0/III	709		56
	Unexplained minutes-long outburst(s) in A dwarf	AQ CVn	III	710		57
	Unexplained subsecond outburst of G supergiant	β Cam	III	711		58
	Unexplained minutes-long outburst in K giant	V654 Her	III	712		59
	Unexplained FU Ori-like outburst	PTF 14jg	0/III	713		60
	Unexplained outburst and variability	ASASSN-19lb	III	714		61
	Unexplained outburst in Sun-like star	ASASSN-20lj	III	715		62
Anomalous stellar flare star	Host of stellar flares with unidentified spectral lines	YZ CMi	III	716		63
Complex magnetic star	Young star with unusually complex magnetic field geometry and decadal rotational variability	Landstreet's Star	0/III	717		64
Hybrid GRB	Peculiar nearby long-duration GRB with no identified supernova, some properties like short GRBs	GRB 060614	0/III/IV	718		65
	Peculiar nearby intermediate-duration GRB with no identified supernova, some properties like long GRBs	GRB 060505	0/III/IV	719		66
Fast radio burster	Magnetar that emitted brilliant millisecond radio transisent	SGR 1935+2154	III	269		67

Table C1 *continued*

Table C1 *(continued)*

Type	Description	Anomaly	Class	ID	Solar?	Ref
Swooshing pulsar	Pulsar with quasiperiodic episodes in which pulses drift	PSR B0919+06	III	720		68
Anomalous variable MSP-WD	MSP-WD binary with strange light curve	PSR J1911-5958A	III	665		69
Red flaring CVs/YSOs	Extremely red (in Gaia photometry) star with unexplained optical flare (0.7 magnitude)	DDE 168	II/III(/IV)	721		70
Dynamically-peculiar globular cluster	Globular cluster with three MSPs observed to have anomalous inner accelerations, and two with discrepant proper motions, distances	NGC 6752	0/III (I)	340		71
Galactic hole	Possible void in center of galaxy	UMi dSph	0/III	722		72
	Anomalous multi-kpc void to one side of galaxy, apparently not due to SF	NGC 247	III/IV	723		73
Variable galaxy	Dwarf galaxy hosts unknown transient, also seems to change in position or morphology over decades	Leoncino Dwarf	III/IV/V	724		74
Anomalous flaring AGN	AGN with days-long symmetric burst in optical light curve, possible self-lensing SMBH binary	Spikey	0/III	725		75
	Weeks long single AGN flare in optical, possibly counterpart to gravitational wave event GW 190521	ZTF19abanrhr	0/III	726		76
Quasi-periodic erupting AGN	AGN with hour-long X-ray flares, occur on regular (several hour) basis	GSN 069	III	727		77
Coherently variable AGN	Coherent picosecond optical variability from AGN	MCG+00-09-070	III	728		78
		Class IV				
Unidentified radio sources	Bright radio source with possible unidentified optical counterpart	3C 141	IV	729		79
	Bright radio source with no counterparts	3C 125	IV	730		80
		3C 431	IV	731		81
	Radio source with no likely counterparts	PMN J1751-2524	IV	732		82
	Unexplained variable radio counterpart to repeating FRB	FRB 121102	0/IV/III	733		83
Odd radio circles	Unexplained disk-shaped arcminute-scale radio sources	ORC 2	IV	734		84
Radio filament	Unexplained narrow synchrotron-emitting filaments	Galactic Center Radio Arc	IV	735		85
Unidentified γ-ray source	Unassociated GeV gamma-ray source off Galactic Plane	3FGL J1539.2-3324	0/IV	736		86
		3FGL J1231.6-5113	IV	737		87

Table C1 *continued*

Table C1 *(continued)*

Type	Description	Anomaly	Class	ID	Solar?	Ref
Dark accelerator	Unassociated TeV gamma-ray source near Galactic Plane	TeV J2032+4130	0/IV	738		88
		HESS J1745-303	IV	739		89
Unidentified radio transient	Sub-minute duration low frequency radio transient	LWAT 171018	IV	740		90
	Minute duration low frequency radio transient	ILT J225347+862146	IV	741		91
	Long duration low frequency radio transient	TGSSADR J183304.4-384046	IV	742		92
	Multi-hour low frequency radio transient	J103916.2+585124	IV	743		93
	Multi-day radio transient	WJN J1443+3439	IV	744		94
	Long-duration radio transient in M82 starburst	43.78+59.3	0/IV	745		95
	Decade-long radio transient	FIRST J141918.9+394036	0/IV	746		96
	5 GHz radio transient	RT 19920826	IV	747		97
Radio burster	Several $>$ 1 Jy radio bursts from inner Galaxy	GCRT J1745-3009	IV	748		98
Non-repeating FRB	Unexplained single millisecond radio transient in host with low star formation	FRB 190523	IV	749		99
Repeating FRB	Unexplained aperiodic millisecond radio transients	FRB 121102	IV/III	733		100
Periodic FRB	Unexplained, periodic millisecond radio transients	FRB 180916.J0158+65	IV	750		101
Unidentified NIR transient	Possible recurrent NIR transient	VVV-WIT-02	0/IV	751		102
Unidentified optical transient	Possible minutes-long recurrent OT	OTS 1809+31	IV	752		103
	Flaring red object	MASTER OT J051515.25+223945.7	IV	753		104
	Fading red point source or red transient	USNO-B1.0 1084-0241525	IV	754		105
Pseudo-afterglow	Fading optical transient caused by extragalactic relativistic explosion	PTF 11agg	0/II/IV	755		106
Intermediate luminosity red transient	Months-long eruption of highly-reddened object, brighter than typical nova but fainter than typical supernova	SN 2008S	IV/III	756		107
Ca-rich gap transient	Weeks-long optical transient, brighter than typical nova but fainter than typical supernova with atypically high Ca/O ratios	PTF 09dav	IV	757		108
Fast blue UV-optical transients	Optical and ultraviolet transient with blue colors that evolved quickly over days	AT 2018cow	IV	758		109
	Extremely bright optical and ultraviolet transient with blue colors that evolved quickly	Dougie	0/IV	759		110
Unidentified X-ray transient	Unexplained minutes-long X-ray transients	XRT 000519	IV	760		111
		CDF-S XT1	0/IV	761		112

Table C1 *continued*

Table C1 *(continued)*

Type	Description	Anomaly	Class	ID	Solar?	Ref
	Ultraluminous minute-long X-ray transient	CXOU J124839.0-054750	IV	762		113
	Ultraluminous years-long X-ray transient	M86 tULX-1	0/II/IV	763		114
Unidentified γ-ray transient	Galactic long GRB-like transient with rapid (< 1 s) optical flaring	Swift J195509.6+261406	IV	764		115
Neutrino coincidence	Coincidence of several neutrinos detected by IceCube	IceCube neutrino multiplet	0/IV	765		116
		Class V				
Impossible eclipsing stars	"Impossible" eclipsing triple star with eclipses that cannot be fit with Kepler's Laws	KIC 2856960	0/V	766		117
ANITA upwards showers	EeV neutrino candidates impossibly propagating through Earth	AAE-061228	V	767		118
		AAE-141220	V	768		119
		AAC-150108	V	769		120

Note—**Class** – classification according to scheme in Section 6.1. A "0" in the class indicates the existence of a partial explanation. **Solar?** – ✓ if object is in or passed through Solar System and listed in Table E1; otherwise listed in Table E2.

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(2006); Gehrels et al. (2006); Gal-Yam et al. (2006); Yang et al. (2015); (66) Ofek et al. (2007); McBreen et al. (2008); Thöne et al. (2014); (67) Scholz & Chime/Frb Collaboration (2020); Bochenek et al. (2020); (68) Rankin et al. (2006); Wahl et al. (2016); (69) Cocozza et al. (2006); (70) Denisenko (2019); (71) D'Amico et al. (2002); Ferraro et al. (2003); (72) Battinelli & Demers (1999); Demers & Battinelli (2001); Bellazzini et al. (2002); (73) Wagner-Kaiser et al. (2014); (74) Filho & Sánchez Almeida (2018); (75) Smith et al. (2018); Hu et al. (2020); (76) Graham et al. (2020); (77) Miniutti et al. (2019); (78) Borra (2013); (79) Martel et al. (1998); Maselli et al. (2016); (80) Maselli et al. (2016); (81) Maselli et al. (2016); (82) Titov et al. (2011); (83) Chatterjee et al. (2017); Margalit & Metzger (2018); (84) Norris et al. (2021); (85) Yusef-Zadeh et al. (1984); Anantharamaiah et al. (1991); (86) Massaro et al. (2015); Salvetti et al. (2017); (87) Acero et al. (2013); Massaro et al. (2015); (88) Aharonian et al. (2002, 2008); Aliu et al. (2014); (89) Aharonian et al. (2008); Hayakawa et al. (2012); Hui et al. (2016); (90) Varghese et al. (2019); (91) Stewart et al. (2016); (92) Murphy et al. (2017); (93) Jaeger et al. (2012); (94) Niinuma et al. (2007); Aoki et al. (2014); (95) Muxlow et al. (2010); Joseph et al. (2011); Gendre et al. (2013); (96) Law et al. (2018); Marcote et al. (2019); (97) Bower et al. (2007); Frail et al. (2012); (98) Hyman et al. (2005); Kaplan et al. (2008); Roy et al. (2010); (99) Ravi et al. (2019); (100) Spitler et al. (2016); Chatterjee et al. (2017); Tendulkar et al. (2017); Bassa et al. (2017); (101) Marcote et al. (2020); Chime/FRB Collaboration et al. (2020); (102) Dekany et al. (2014); (103) Hudec et al. (1990); (104) Balanutsa et al. (2015); (105) Villarroel et al. (2016, 2020); (106) Cenko et al. (2013); (107) Prieto et al. (2008); Smith et al. (2009); Thompson et al. (2009); (108) Sullivan et al. (2011); Kasliwal et al. (2012); (109) Drout et al. (2014); Pursiainen et al. (2018); Prentice et al. (2018); Margutti et al. (2019); (110) Vinkó et al. (2015); Arcavi et al. (2016); (111) Jonker et al. (2013); (112) Bauer et al. (2017); (113) Sivakoff et al. (2005); (114) van Haaften et al. (2019); (115) Kasliwal et al. (2008); Stefanescu et al. (2008); Castro-Tirado et al. (2008); (116) Icecube Collaboration et al. (2017); (117) Marsh et al. (2014); Wright et al. (2016); (118) Gorham et al. (2018); (119) Gorham et al. (2018); (120) Aartsen et al. (2020)

Table C2. Anomaly (SETI) sample

Type	Description	Program	Candidate	Class	ID
		Class II			
IR excess stars	MIR-bright star	C09	IRAS 16406-1406	II/III	770
		C09	IRAS 20331+4024	II/III	771
		C09	IRAS 20369+5131	II/III	772
	MIR-bright star cluster	Ĝ	IRAS 04287+6444	0/II	773
	Microwave-excess star	L16	UW CMi	0/II	774
IR excess galaxies	MIR-bright galaxy	Ĝ	WISE J224436.12+372533.6	II	775
	MIR-radio correlation outlier	Ga15	UGC 3097	II	776
			NGC 814	II	777
			ESO 400-28	II	778
			MCG+02-60-017	II	779
Abnormally faint star	Luminosity discrepant with spectral type	Z18	TYC 6111-1162-1	0/II	780
Underluminous galaxy	Disk galaxies too faint for Tully-Fisher relation	Z15	UGC 5394	II	781
			NGC 4502	II	782
			NGC 4698	II	783
			IC 3877	II	784
			AGC 470027	II	785
		Class III			
Narrowband radio star	Narrowband radio emission from star	B92	HR 6171	III	786
		SERENDIP III	GJ 1019	III	787
			GJ 299	III	788
		P19	LHS 1140	0/III	088
			TRAPPIST-1	0/III	091
Optical pulse star	Nanosecond optical pulses from star	Harvard OSETI	HD 220077	0/III	789
			HIP 107359	0/III	790
Coherently variable star	Coherent picosecond optical variability from star	BT16	TYC 3010-1024-1	III	791
		Class IV			
Narrowband radio source	Narrowband transient	Big Ear	Wow! Signal (A)	IV	792
			Wow! Signal (B)	IV	793
	Ultranarrowband radio emission	SERENDIP III	5.13h +2.1	IV	794
		META	08.00h -08.50	IV	795
			03.10h +58.0	IV	796
		META II	11.03.91	IV	797
Unidentified IR source	Unidentified MIR candidate galaxies	Ĝ	WISE 0735-5946	IV	798
		Ĝ	IRAS 16329+8252	IV	799
Vanishing star-like source	Apparent star disappearing between archival images	V16	USNO-B1.0 1084-0241525	IV	754

NOTE—All sources in this sample are sidereal.

References—B92: Blair et al. (1992); Big Ear: Dixon (1985), Gray (2012); BT16: Borra & Trottier (2016); C09: Carrigan (2009); Ĝ: Griffith et al. (2015); Ga15: Garrett (2015); Harvard OSETI: Howard et al. (2004); L16: Lacki (2016); META: Horowitz & Sagan (1993); META II: Colomb et al. (1995); P19: Pinchuk et al. (2019); SERENDIP III: Bowyer et al. (2016); V16: Villarroel et al. (2016); Z15: Zackrisson et al. (2015); Z18: Zackrisson et al. (2018)

Table C3. Anomalies excluded from *Exotica Catalog*

Type	Description	Anomaly	Class	Reason excluded	Ref
		Class II			
NS-BH mass gap object	Gravitational wave event involving 2.6 $M_\odot$ compact object, in between the expected mass of a neutron star and stellar mass black hole	GW190814	II	Insufficiently localized	1
Pair SN mass gap black hole	Gravitational wave event involving 85^{+21}_{-14} $M_\odot$ black hole, in mass range where pair instability supernovae are expected to leave no remnants	GW190521	II	Insufficiently localized	2
		Class III			
Biotic planet	Planet with biosphere of poorly constrained origin	Earth	0/III	Impractical to observe as whole	3
Fermi Bubbles	Kiloparsec-scale bipolar bubbles visible in radio, X-rays, and gamma-rays extending out of Galactic Center	Fermi Bubbles	0/III/IV	Too large on sky	4
		Class IV			
Milagro hot spots	TeV cosmic ray hotspots located in tail of heliosphere	Milagro region A	0/IV	Too large on sky	5
		Milagro region B	0/IV	Too large on sky	5
Great Annihilator	Region of excess positron annihilation emission around Galactic Center	Great Annihilator	0/IV	Too large on sky	6
Galactic Center GeV excess	Region of excess GeV gamma-ray emission around Galactic Center	(Galactic Center)	0/IV	Somewhat large on sky	7
ARCADE 2 radio excess	Inexplicably strong cosmic radio background	···	IV	Diffuse	8
TeV $e^{\pm}$ excess	Excess of TeV electrons and positrons, with high positron fraction, over expectations from cosmic ray propagation models	···	0/IV/V	Diffuse	9
IceCube neutrino background	Astrophysical neutrinos of TeV–PeV energy	···	IV	Diffuse	10
Ultrahigh energy cosmic rays	Cosmic rays of EeV energy from unknown sources	···	0/IV	Diffuse	11
Great Silence	Unexpected lack of technosignatures in local Universe given its age and possibility of interstellar travel	···	0/IV	Non-localized	12
		Class V			
Missing mass	Implied extra mass/gravity from galactic rotation curves, attributed to dark matter (or MOND)	···	V	Ubiquitous	13
	Non-baryonic mass implied by CMB power spectrum and lensing maps of galaxy clusters	···	V	Ubiquitous	14
Cosmic acceleration	Accelerating expansion of Universe, attributed to dark energy	···	V	Non-localized	15
Hubble tension	Inconsistency in measured H_0 between early Universe tests and distance ladder measurements	···	V	Non-localized	16

Table C3 *continued*

Table C3 *(continued)*

Type	Description	Anomaly	Class	Reason excluded	Ref

References—(1) Abbott et al. (2020); (2) The LIGO Scientific Collaboration et al. (2020); Graham et al. (2020); De Paolis et al. (2020); (3) Sagan et al. (1993); (4) Dobler & Finkbeiner (2008); Su et al. (2010); Kataoka et al. (2013); (5) Abdo et al. (2008); (6) Knödlseder et al. (2005); Prantzos et al. (2011); (7) Hooper & Goodenough (2011); Ackermann et al. (2017); (8) Seiffert et al. (2011); Singal et al. (2018); (9) Chang et al. (2008); Adriani et al. (2009); (10) Aartsen et al. (2014); IceCube Collaboration et al. (2018b); Murase et al. (2018); (11) Kotera & Olinto (2011); (12) Brin (1983); Cirkovic (2009, 2018); (13) Rubin et al. (1980); Famaey & McGaugh (2012); (14) Clowe et al. (2006); Spergel et al. (2007); (15) Riess et al. (1998); Perlmutter et al. (1999); (16) Verde et al. (2019)

D. THE CONTROL SAMPLE

All objects in the Control sample are listed in Table D1.

Table D1. Control sample

Object	Original explanation	Class	Ref	Current explanation	Ref	ID
CSL-1	Cosmic string as gravitational lens	0/IV	1	Galaxy pair	2	800
GRB 090709A	GRB with 8 sec quasi-periodic oscillations	III	3	GRB with no periodicity	4	801
GW100916 (A)	First BH merger observed in gravitational waves	0	5	Planned blind injection	5	802
GW100916 (B)		0	5		5	803
HD 117043	Potassium line-emitting stellar flares	III	6	Matches in observatory	7	804
Hertzsprung's Object	Bright optical transient	IV	8	Static electric discharge on photographic plate	9	805
HIP 114176	Star in the *Hipparcos* catalog	0	10	Scattered light from bright star	10	806
KIC 5520878	RR Lyr with prime number signal in autocorrelation of period lengths	III	11	Fluke from natural two period variability	11	807
KIC 9832227	Imminent stellar merger and LRN	0	12	Triple stellar system with W UMa-type inner binary; timing typo	13	808
KOI 6705.01	Variable Moon-sized transiter	III	14	Detector problem	14	809
Perseus Flasher	Bright optical short transients	IV	15	Satellite glints or physiological response	16	810
PSR B1829-10 b	First exoplanet discovered	I/III	17	Pulsar timing correction error	18	811
OT 060420	Bright optical transient	IV	19	CR hit coincidence	20	812
SSSPM J1549-3544	Candidate nearest white dwarf	0	21	Distant halo star	22	813
Swift Trigger 954840	Candidate gamma-ray burst	0	23	Statistical fluctuation	24	814
TU Leo	Dwarf nova	0	25	Background star coincident with bright asteroid 8 Flora	25	815
VLA J172059.9+385226.6	Unknown radio transient	IV	26	Incorrect metadata with regard to pointing	26	816

NOTE—All sources in this sample are sidereal.

References—(1): Sazhin et al. (2003); (2): Agol et al. (2006); (3): Markwardt et al. (2009); Golenetskii et al. (2009); Gotz et al. (2009); (4): de Luca et al. (2010); Cenko et al. (2010); (5): Evans et al. (2012); (6): Barbier & Morguleff (1962); (7): Wing et al. (1967); (8): Hertzsprung (1927); Klemola (1983); (9): Schaefer (1983); (10): Perryman et al. (1997); (11): Hippke et al. (2015); (12): Molnar et al. (2017); (13): Socia et al. (2018); Kovacs et al. (2019); (14): Gaidos et al. (2016); Coughlin et al. (2016); (15): Katz et al. (1986); (16): Halliday et al. (1987); Corso et al. (1987); Maley (1987); Schaefer et al. (1987); Borovicka & Hudec (1989); (17): Bailes et al. (1991); (18): Lyne & Bailes (1992); (19): Shamir & Nemiroff (2006); (20): Shamir & Nemiroff (2006); Smette (2006); Nemiroff & Shamir (2006); (21): Scholz et al. (2004); (22): Farihi et al. (2005); (23): Lipunov et al. (2020); Gropp et al. (2020); (24): Gropp et al. (2020); (25): Schmadel et al. (1996); (26): Ofek et al. (2010)

E. THE FULL *EXOTICA CATALOG*

E.1. *Notes on data sources*

Much of the data used in Figures 4–6 comes from papers on individual sources on the literature.

For Solar System bodies, we consulted the Jet Propulsion Laboratory's Solar System Dynamics pages[5], particularly the Small Solar System Browser[6]. When masses were unavailable, we estimated them by assuming that objects interior to Jupiter had density 3 $\mathrm{g\,cm^{-3}}$ and the rest had density 2 $\mathrm{g\,cm^{-3}}$.

[5] https://ssd.jpl.nasa.gov/

[6] https://ssd.jpl.nasa.gov/sbdb.cgi

We relied on Simbad data for the bulk of Table E2. Stellar data was partly based on *Gaia* distances, colors, and extinctions (Gaia Collaboration et al. 2018); extinctions from Savage et al. (1985) and Gudennavar et al. (2012); PASTEL effective temperatures and surface gravities (Soubiran et al. 2016); *Hipparcos* photometry and distances (Perryman et al. 1997); and individualized references. For the I17 stars plotted in Figure 5, it was impractical to find individualized sources; we supplemented with data from Holmberg et al. (2007), Takeda et al. (2007), CATSUP (Hinkel et al. 2017), and Swihart et al. (2017). Frequently, we had to calculate the luminosity and/or surface temperature from other quantities (mass, radius, bolometric flux, angular size, and distance). When no other data was available for these quantities, we estimated bolometric corrections and effective temperatures using the color conversions of Flower (1996), as corrected by Torres (2010).

Additional references for Figure 4 as listed in Table E2: (13) Santerne et al. (2018); (15) Buldgen et al. (2019); (17) Anglada-Escudé et al. (2016); (20) Ribas et al. (2018); (22) Dittmann et al. (2017); (24) Díaz et al. (2016); Tuomi et al. (2013); (26) Crida et al. (2018); (28) Gonzales et al. (2019); Wang et al. (2017); (30) Armstrong et al. (2020); (33) Konacki & Wolszczan (2003); Pavlov et al. (2007); (35) von Braun et al. (2012); (38) Hartman et al. (2011); (39) Charbonneau et al. (2009); (41) Lovis et al. (2005); (44) Brahm et al. (2016); (46) Bouchy et al. (2005); Boyajian et al. (2015); (48) del Burgo & Allende Prieto (2016); (50) Cochran et al. (2011); (52) Gravity Collaboration et al. (2019a); Marois et al. (2008, 2010); (54) Santos et al. (2001); Wittenmyer et al. (2009); (56) Hébrard et al. (2010); Liu et al. (2018); (58) Bakos et al. (2007); (60) Hatzes et al. (2006); O'Gorman et al. (2017); (63) Doyle et al. (2011); Moorman et al. (2019); (365) Jontof-Hutter et al. (2015); (369) Bernkopf et al. (2012); Feng et al. (2017); Pepe et al. (2011); (373) Zhou et al. (2017); (375) Libby-Roberts et al. (2020); Masuda (2014); (376) Gaudi et al. (2017); (378) Barclay et al. (2012); (380) Donati et al. (2016); (382) Currie et al. (2018); (384) Sato et al. (2012); (387) Hollands et al. (2018); Luhman et al. (2012); Rodriguez et al. (2011); (388) Isella et al. (2016); Pinte et al. (2018).

Other references for the stellar CMD in Figure 5 as listed in Table E2: (2) Rappaport et al. (2016); (5) Macías et al. (2018); (6) Heiter et al. (2015); (7) Ballering et al. (2017); (36) Reid et al. (2004); (42) Stassun et al. (2017); (45) Brahm et al. (2016); (49) del Burgo & Allende Prieto (2016); (55) Tinney et al. (2011); (59) Bakos et al. (2007); (68) Tannirkulam et al. (2008); (82) Dieterich et al. (2014); Lépine & DiStefano (2012); (85) Díaz et al. (2019); (86) Heiter et al. (2015); (87) Heiter et al. (2015); (88) Heiter et al. (2015); (89) Ribas et al. (2010); (90) Heiter et al. (2015); (92) Swihart et al. (2017); (96) Swihart et al. (2017); (98) Baines et al. (2018); (99) Gordon et al. (2018a); (101) Markova et al. (2018); (102) Baines et al. (2013); (108) Heiter et al. (2015); (111) For & Sneden (2010); (112) Benedict et al. (2011); (114) For & Sneden (2010); (115) Ohnaka et al. (2019); (124) da Silva et al. (2006); (125) Heiter et al. (2015); (127) Bennett et al. (1996); (128) Heiter et al. (2015); (129) Torres et al. (2015); (131) Heiter et al. (2015); (133) Cruzalèbes et al. (2013); (139) Harper et al. (2008); (140) van Genderen et al. (2019); (141) Zhang et al. (2012a); (144) Morris et al. (2004); van der Hucht (2001); (146) North et al. (2007); (148) Clark et al. (2012); Crowther et al. (2006); (149) Groh et al. (2009); (150) Damineli et al. (2019); Shull & Danforth (2019); (153) Allende Prieto & del Burgo (2016); (154) Kochukhov & Wade (2010); (158) Heiter et al. (2015); (161) Heiter et al. (2015); (162) Heiter et al. (2015); (165) Kaye et al. (1999); (167) Gordon et al. (2019); (170) O'Donoghue et al. (1997); (178) Guinan & Robinson (1986); (180) Howell et al. (2013); Yudin et al. (2002); (182) Jeffery et al. (2001); (184) Geier et al. (2017); (185) Geier et al. (2017); (187) Plez & Cohen (2005); (188) Gordon et al. (2018a); (189) Heber et al. (2008); (193) Holberg et al. (2016); (199) Preval et al. (2013); (203) Sahu et al. (2017); (204) Holberg et al. (2016); Hollands et al. (2018); (208) Holberg et al. (2016); (232) Torres & Ribas (2002); (233) Torres & Ribas (2002); (363) Mamajek et al. (2012); (370) Bernkopf et al. (2012); (371) Zhou et al. (2017); (374) Zhou et al. (2017); (386) Stassun et al. (2017); (390) Crowther et al. (2010); Doran et al. (2013); (394) Geier et al. (2017); (396) Gordon et al. (2018b); Zhang et al. (2012b); (403) Koposov et al. (2020); (407) Dahn et al. (2004); (409) Werner & Rauch (2015); (429) Tokovinin (2018); (476) Vos et al. (2018); (477) Vos et al. (2018); (488) Hawkins et al. (2016); (489) Trundle et al. (2001); (490) Geier et al. (2017); (492) Masseron et al. (2020); (494) Geller et al. (2017); Mathieu et al. (2003); (500) Boyajian et al. (2016); (510) Andrews (1996); (511) Brown et al. (2008); (513) Bailer-Jones (2011); (542) Zackrisson et al. (2018); (545) Sandage (1997); (546) Rayner et al. (2009); (547) Cvetković (2011); (548) Ruiz-Dern et al. (2018); (560) Farihi et al. (2005). Supplementary data for the I17 stars comes from: Baines et al. (2018); Heiter et al. (2015); Swihart et al. (2017).

Other references for the HR diagram in Figure 5 as listed in Table E2: (1) Bonnefoy et al. (2013); (2) Rappaport et al. (2016); (3) Sokal et al. (2018); (4) Bodman et al. (2017); (5) Macías et al. (2018); (6) Heiter et al. (2015); (7) Ballering et al. (2017); (8) Peterson et al. (2006); (9) Weinberger (2008); (10) Su et al. (2007); (11) Jura (2003); (12) Gänsicke et al. (2019); (14) Santerne et al. (2018); (16) Buldgen et al. (2019); (18) Anglada-Escudé et al. (2016); (19) Sanchis-Ojeda et al. (2013); (21) Ribas et al. (2018); (23) Dittmann et al. (2017); (25) Tuomi et al. (2013); (27) Bourrier et al. (2018); (29) Gonzales et al. (2019); (31) Armstrong et al. (2020); (32) Rappaport et al. (2012); (34) Borucki et al. (2012); (37) von Braun et al. (2012); (40) Charbonneau et al. (2009); (43) Schwarz et al. (2007); Stassun et al. (2017); (45) Brahm et al. (2016); (47) Poppenhaeger et al. (2013); (49) del Burgo & Allende Prieto (2016); (51) Cochran et al. (2011); (53) Marois et al. (2008); (55) Tinney et al. (2011); (57) Hébrard et al. (2010); Liu et al. (2018); (59) Bakos et al. (2007); (61) O'Gorman et al. (2017); (64) Doyle et al. (2011); (65) Ceccarelli et al. (2000); (68) Tannirkulam et al. (2008); (69) Leggett et al. (2017); (71) Leggett et al.

(2017); (72) Del Burgo et al. (2009); (73) Dieterich et al. (2018); King et al. (2010); (74) Faherty et al. (2014); Garcia et al. (2017); (76) Faherty et al. (2014); Garcia et al. (2017); (78) Dupuy et al. (2009); (79) Cushing et al. (2008); (80) Basri et al. (1996); Basri & Martín (1999); (81) Dieterich et al. (2014); (83) Dieterich et al. (2014); (84) Dieterich et al. (2014); (85) Díaz et al. (2019); (86) Heiter et al. (2015); (87) Heiter et al. (2015); (88) Heiter et al. (2015); (89) Ribas et al. (2010); (90) Heiter et al. (2015); (91) Boyajian et al. (2012); (92) Swihart et al. (2017); (93) Zhao et al. (2009); (94) Jones et al. (2015); (95) Monnier et al. (2012); (96) Swihart et al. (2017); (97) McCarthy & White (2012); (98) Baines et al. (2018); (99) Gordon et al. (2018a); (100) Blomme et al. (2011); (101) Markova et al. (2018); (103) Baines et al. (2018); (104) Li et al. (2019); (105) Heiter et al. (2015); (106) David & Hillenbrand (2015); (107) Rau et al. (2018); (108) Heiter et al. (2015); (109) Heiter et al. (2015); (110) Gray (2016); (111) For & Sneden (2010); (112) Benedict et al. (2011); (114) For & Sneden (2010); (115) Ohnaka et al. (2019); (116) Libert et al. (2010); (117) Groenewegen et al. (2012); Menten et al. (2012); (118) Justtanont et al. (2013); (120) Witt et al. (2009); (122) Hadjara et al. (2018); (123) Torres et al. (2015); (124) da Silva et al. (2006); (126) Halabi & Eid (2015); Heiter et al. (2015); (127) Bennett et al. (1996); (128) Heiter et al. (2015); (129) Torres et al. (2015); (130) Natale et al. (2008); (131) Heiter et al. (2015); (132) Neilson et al. (2016); (133) Cruzalèbes et al. (2013); (134) Groenewegen & Sloan (2018); (136) Pablo et al. (2017); (137) Zorec et al. (2009); (138) Aufdenberg et al. (2002); (139) Harper et al. (2008); (140) van Genderen et al. (2019); (142) Wittkowski et al. (2012); Zhang et al. (2012a); (145) Morris et al. (2004); (146) North et al. (2007); (147) Tramper et al. (2015); (148) Clark et al. (2012); Crowther et al. (2006); (149) Groh et al. (2009); (151) Hillier et al. (2001); Mehner et al. (2019); Shull & Danforth (2019); (153) Allende Prieto & del Burgo (2016); (154) Kochukhov & Wade (2010); (155) Ciardi et al. (2007); (156) Burgasser et al. (2008); (157) Anglada-Escude et al. (2014); (158) Heiter et al. (2015); (159) Mortier et al. (2012); (160) Heiter et al. (2015); (161) Heiter et al. (2015); (162) Heiter et al. (2015); (163) Christlieb et al. (2002); Norris et al. (2013); (164) Woodruff et al. (2004); (165) Kaye et al. (1999); (166) De Ridder et al. (1999); (167) Gordon et al. (2019); (168) Pietrukowicz et al. (2017); (169) Blanchette et al. (2008); (170) O'Donoghue et al. (1997); (171) Latour et al. (2011); (172) Kervella et al. (2016); (173) Hallinan et al. (2006); (174) Kochukhov et al. (2014); (175) Loebman et al. (2015); (177) Leiner et al. (2016); (179) Guinan & Robinson (1986); Jetsu et al. (1993); Korhonen et al. (1999); (181) García-Hernández et al. (2011); Howell et al. (2013); (182) Jeffery et al. (2001); (183) Fossati et al. (2010); (184) Geier et al. (2017); (185) Geier et al. (2017); (186) Şener & Jeffery (2014); (187) Plez & Cohen (2005); (188) Gordon et al. (2018a); (189) Heber et al. (2008); (190) Brown et al. (2005); (191) Kaplan et al. (2014a); (192) Bédard et al. (2017); (193) Holberg et al. (2016); (194) Holberg et al. (2016); (195) Jahn et al. (2007); (196) Raddi et al. (2018); (197) Shen et al. (2018); (199) Preval et al. (2013); (200) Holberg et al. (2016); Hollands et al. (2018); (201) Bischoff-Kim et al. (2019); (202) Bohlin & Koester (2008); (203) Sahu et al. (2017); (204) Holberg et al. (2016); Hollands et al. (2018); (205) Dreizler & Werner (1996); (206) Dufour et al. (2008); (207) Gänsicke et al. (2010); (208) Holberg et al. (2016); (209) Romero et al. (2012); (210) Serenelli et al. (2019); (228) Porto de Mello et al. (2008); Pourbaix & Boffin (2016); (229) Ratzka et al. (2009); Schaefer et al. (2020); (230) Bergeron et al. (1989); (232) Torres & Ribas (2002); (233) Torres & Ribas (2002); (234) Hoard et al. (2010); (236) Masuda et al. (2019); (237) Xiang et al. (2020); (361) Luhman et al. (2005); (364) Mamajek et al. (2012); Mentel et al. (2018); (366) Jontof-Hutter et al. (2015); (367) Barclay et al. (2013); (368) Bernkopf et al. (2012); (370) Bernkopf et al. (2012); (372) Rappaport et al. (2013); (374) Zhou et al. (2017); (377) Gaudi et al. (2017); (379) Esteves et al. (2015); (381) Donati et al. (2016); (383) Currie et al. (2018); (385) Stock et al. (2018); (386) Stassun et al. (2017); (389) Natta et al. (2004); (391) Crowther et al. (2010, 2016); (393) von Boetticher et al. (2017); (395) La Palombara et al. (2019); (396) Gordon et al. (2018b); Zhang et al. (2012b); (398) Wittkowski et al. (2017); (399) Keller et al. (2014); (400) von Braun et al. (2014); (401) Caffau et al. (2011); (402) Peißker et al. (2020); (403) Koposov et al. (2020); (405) Hermes et al. (2013); (407) Dahn et al. (2004); (409) Werner & Rauch (2015); (411) Brinkworth et al. (2013); (412) Kilic et al. (2012); (423) Best et al. (2017); (425) Tehrani et al. (2019); (427) Burdge et al. (2019); (476) Vos et al. (2018); (477) Vos et al. (2018); (480) Habibi et al. (2017); (482) Martins et al. (2007); (487) Mkrtichian et al. (2008); (488) Hawkins et al. (2016); (489) Trundle et al. (2001); (491) Green et al. (2011); (492) Masseron et al. (2020); (495) Mathieu et al. (2003); (496) Spezzi et al. (2011); (498) Andrews et al. (2016); (500) Boyajian et al. (2016); (501) Rappaport et al. (2019); (502) Gaia Collaboration et al. (2018); (503) Lyubimkov et al. (2010); (504) Pilecki et al. (2018); (505) Järvinen et al. (2018); (506) McCollum & Laine (2019a); (507) McCollum & Laine (2019b); (509) Fokin et al. (2004); Stankov et al. (2003); (511) Brown et al. (2008); (512) Lyubimkov et al. (2010); (513) Bailer-Jones (2011); (515) Gaia Collaboration et al. (2018); (517) Gaia Collaboration et al. (2018); (519) Kowalski et al. (2010); (520) Krtička et al. (2007); Landstreet et al. (2007); Shultz et al. (2019); (542) Zackrisson et al. (2018); (547) Cvetković (2011); (558) Gaidos et al. (2016). Supplementary data for the I17 stars comes from: Aguilera-Gómez et al. (2018); Anglada-Escude et al. (2014); Anglada-Escudé et al. (2016); Baines et al. (2018); Bonnefoy et al. (2013); Boyajian et al. (2012); Dieterich et al. (2014); Dupuy et al. (2009); Hadjara et al. (2018); Heiter et al. (2015); Jones et al. (2015); Kolbas et al. (2015); McCarthy & White (2012); Monnier et al. (2012); Rau et al. (2018); Swihart et al. (2017); von Braun et al. (2014); Zhao et al. (2009).

Galaxy data was partly based on NED redshifts and photometry from 2MASS (Skrutskie et al. 2006), de Vaucouleurs et al. (1991), and Data Releases 9 and 12 of the Sloan Digital Sky Survey (Ahn et al. 2012; Alam et al. 2015). For I17 galaxies, we relied mainly on the B-band magnitudes in I17 itself and the photometry in Mateo (1998). Because photometry in u and r bands was frequently unavailable, we relied heavily on the color transformations of Blanton

& Roweis (2007), Jester et al. (2005), and Lupton's equations[7] to derive the approximate colors for use in Figure 6. Redshifts were converted to luminosity distances assuming $H_0 = 70\ \mathrm{km\,s^{-1}\ Mpc^{-1}}$, $\Omega_m = 0.3$, and $\Omega_\Lambda = 0.7$. In some cases, the stellar mass was calculated from K_s absolute magnitudes using the conversion of Cappellari (2013). I17 galaxy star-formation rates were largely calculated from GALEX ultraviolet and IRAS total infrared luminosities (Bai et al. 2015; Sanders et al. 2003), using the corrections of Hao et al. (2011), with additional data from Licquia et al. (2015), Jarrett et al. (2019), and McConnachie (2012).

Other references for the galaxy CMD in Figure 6 as listed in Table E2: (238) Baumgardt & Hilker (2018); Harris (2010); (240) Baumgardt & Hilker (2018); Harris (2010); (242) Harris (2010); (245) Harris (2010); (248) Baumgardt & Hilker (2018); Harris (2010); (263) Shaya et al. (1994); (280) Jarrett et al. (2019); (281) Jarrett et al. (2019); (282) Jarrett et al. (2019); (283) Boselli et al. (2015); (284) Jarrett et al. (2019); (286) Norris & Kannappan (2011); Norris et al. (2015); (287) Jarrett et al. (2019); (289) McConnachie (2012); (290) Trujillo et al. (2014); (293) Thilker et al. (2010); (294) Jarrett et al. (2019); (295) Jarrett et al. (2019); (296) McConnachie (2012); Prugniel & Heraudeau (1998); (297) Wei et al. (2010); (299) Peeples et al. (2008); (301) Jarrett et al. (2019); (303) Jarrett et al. (2019); (304) Jarrett et al. (2019); (307) Jarrett et al. (2019); (308) Dale et al. (2007); Jarrett et al. (2019); (310) Jarrett et al. (2019); (312) Karachentsev et al. (2004); (322) Jarrett et al. (2019); (326) Annibali et al. (2013); (327) Loose & Thuan (1986); (329) Micheva et al. (2017); (338) Croft et al. (2006); (339) Boissier et al. (2016); (340) Pandya et al. (2018); (342) Trujillo et al. (2017); (344) Spavone et al. (2010); (347) Kenney et al. (2014); (348) Jarrett et al. (2019); (349) Jarrett et al. (2019); (350) Jarrett et al. (2019); (351) Jarrett et al. (2019); (352) Jarrett et al. (2019); (353) Matthews et al. (1999); (432) Buzzoni et al. (2012); Platais et al. (2011); (433) Meylan et al. (2001); (436) Sandoval et al. (2015); (439) Baumgardt & Hilker (2018); Harris (2010); (442) Baumgardt & Hilker (2018); Harris (2010); (448) Sandoval et al. (2015); (458) Brunker et al. (2019); (460) Izotov et al. (2018); (461) Jarrett et al. (2019); (465) Ogle et al. (2016, 2019); (485) Caldwell et al. (2014); (522) Mateo (1998); McConnachie (2012); (523) Jarrett et al. (2019); (524) Filho & Sánchez Almeida (2018); (543) Gómez-López et al. (2019). Supplementary CMD data for I17 galaxies comes from: de Vaucouleurs & Ables (1968); Lauberts (1982); Licquia & Newman (2015); Mateo (1998); Prugniel & Heraudeau (1998).

Other references for the $M_\star$–SFR plot in Figure 6 as listed in Table E2: (264) Varenius et al. (2016); (287) Jarrett et al. (2019); (294) Jarrett et al. (2019); (295) Jarrett et al. (2019); (298) Erroz-Ferrer et al. (2013); (300) Gu et al. (2006); Peeples et al. (2008); (301) Jarrett et al. (2019); (303) Jarrett et al. (2019); (304) Jarrett et al. (2019); (305) Ogle et al. (2016, 2019); (307) Jarrett et al. (2019); (309) Mateo (1998); (311) Madore et al. (2018); Mateo (1998); (313) Karachentsev et al. (2004); Meier et al. (2001); (314) Gladders et al. (2013); (316) Di Teodoro et al. (2018); Yuan et al. (2011); (318) Girard et al. (2018); (320) Marques-Chaves et al. (2018); (322) Jarrett et al. (2019); (324) Cortijo-Ferrero et al. (2017); (325) Cluver et al. (2008); (326) Annibali et al. (2013); (328) Loose & Thuan (1986); Summers et al. (2001); (329) Micheva et al. (2017); (330) Vanzella et al. (2016); (332) Berg et al. (2018); (334) Dessauges-Zavadsky et al. (2015); (336) Swinbank et al. (2010); Zhang et al. (2018); (338) Croft et al. (2006); (339) Boissier et al. (2016); (342) Trujillo et al. (2017); (344) Spavone et al. (2010); (345) Finkelman et al. (2011); (346) Brandl et al. (2009); Lahén et al. (2018); (348) Jarrett et al. (2019); (350) Jarrett et al. (2019); (351) Jarrett et al. (2019); (352) Jarrett et al. (2019); (450) Ma et al. (2016); (452) Toba et al. (2020); (454) Oesch et al. (2016); (456) Lam et al. (2019); (458) Brunker et al. (2019); (460) Izotov et al. (2018); (461) Jarrett et al. (2019); (463) Ogle et al. (2016, 2019); (465) Ogle et al. (2016, 2019); (467) Yuan et al. (2017); (468) Bayliss et al. (2020); (470) Cava et al. (2018); (523) Jarrett et al. (2019); (524) Filho & Sánchez Almeida (2018); (541) Vaddi et al. (2016); (544) Erroz-Ferrer et al. (2013).

E.2. *Tables of the catalog*

Table E1 lists all Solar System sources in the Exotica Catalog. Table E2 lists all sidereal sources in the Exotica Catalog. Table E3 lists relationships between sidereal sources in the Catalog, and between Catalog sources and objects in I17.

Table E1. The *Exotica Catalog*: Solar System targets

ID	Name	Samples	Phyla	Primary	a	e	i	$a_\odot$ (AU)	MOID$_\oplus$ (AU)	Θ	Ref
1	446 Aeternitas	P	Minor body	Sun	2.79 AU	0.126	10.62	2.79	1.45	· · ·	
2	52 Europa	P	Minor body	Sun	3.09 AU	0.110	7.48	3.09	1.77	0.2″	

Table E1 *continued*

[7] As presented at http://classic.sdss.org/dr6/algorithms/sdssUBVRITransform.html.

Table E1 *(continued)*

ID	Name	Samples	Phyla	Primary	a	e	i	$a_{\odot}$ (AU)	$\mathrm{MOID}_{\oplus}$ (AU)	Θ	Ref
3	624 Hektor	P	Minor body	Sun	5.26 AU	0.023	18.16	5.26	4.15	···	
4	434 Hungaria	P	Minor body	Sun	1.94 AU	0.074	22.51	1.94	0.83	···	
5	16 Psyche	P	Minor body	Sun	2.92 AU	0.134	3.10	2.92	1.54	0.″2	
6	3628 Božněmcová	P	Minor body	Sun	2.54 AU	0.297	6.88	2.54	0.78	···	
7	420 Bertholda	P	Minor body	Sun	3.41 AU	0.030	6.69	3.41	2.33	···	
8	1862 Apollo	P	Minor body	Sun	1.47 AU	0.560	6.35	1.47	0.03	···	
9	349 Dembowska	P	Minor body	Sun	2.92 AU	0.092	8.25	2.92	1.66	0.″1	
10	15 Eunomia	P	Minor body	Sun	2.64 AU	0.186	11.75	2.64	1.19	0.″3	
11	233 Asterope	P	Minor body	Sun	2.66 AU	0.099	7.69	2.66	1.40	···	
12	4 Vesta	P	Minor body	Sun	2.36 AU	0.089	7.14	2.36	1.14	0.″6	
13	90 Antiope	P	Minor body	Sun	3.15 AU	0.166	2.21	3.15	1.61	···	
14	Dactyl	P	Minor body	243 Ida	90 km	···	···	2.86	1.75	···	
15	3200 Phaethon	P	Minor body	Sun	1.27 AU	0.890	22.26	1.27	0.02	0.″4	
16	2020 AV_2	PS	Minor body	Sun	0.56 AU	0.177	15.87	0.56	0.35	···	
17	(322756) 2001 CK_{32}	P	Minor body	Sun	0.73 AU	0.383	8.13	0.73	0.08	···	
18	163693 Atira	P	Minor body	Sun	0.74 AU	0.322	25.62	0.74	0.21	···	
19	3753 Cruithne	P	Minor body	Sun	1.00 AU	0.515	19.81	1.00	0.07	···	
20	1991 VG	P	Minor body	Sun	1.03 AU	0.052	1.43	1.03	0.00	···	
21	2010 TK_7	P	Minor body	Sun	1.00 AU	0.190	20.90	1.00	0.08	···	
22	(469219) Kamo'oalewa	P	Minor body	Sun	1.00 AU	0.103	7.79	1.00	0.03	···	
23	4660 Nereus	P	Minor body	Sun	1.49 AU	0.360	1.43	1.49	0.00	0.″1	
24	433 Eros	P	Minor body	Sun	1.46 AU	0.223	10.83	1.46	0.15	0.″2	
25	5261 Eureka	P	Minor body	Sun	1.52 AU	0.065	20.28	1.52	0.50	···	
26	8 Flora	P	Minor body	Sun	2.20 AU	0.156	5.89	2.20	0.88	0.″2	
27	25 Phocaea	P	Minor body	Sun	2.40 AU	0.255	21.61	2.40	0.92	···	
28	65 Cybele	P	Minor body	Sun	3.42 AU	0.112	3.56	3.42	2.03	0.″2	
29	153 Hilda	P	Minor body	Sun	3.98 AU	0.140	7.82	3.98	2.41	···	
30	6P/d'Arrest	P	Minor body	Sun	3.50 AU	0.611	19.48	3.50	0.35	···	
31	21P/Giacobini-Zinner	P	Minor body	Sun	3.50 AU	0.710	32.00	3.50	0.02	0.″2	
32	1P/Halley	P	Minor body	Sun	17.83 AU	0.967	162.26	17.83	0.06	0.″2	
33	C/2014 S3 (PAN-STARRS)	P	Minor body	Sun	90.46 AU	0.977	169.32	90.46	1.09	···	
34	5335 Damocles	P	Minor body	Sun	11.84 AU	0.866	61.60	11.84	0.61	···	
36	2P/Encke	P	Minor body	Sun	2.22 AU	0.848	11.78	2.22	0.17	···	
37	133P/Elst-Pizarro	P	Minor body	Sun	3.16 AU	0.157	1.39	3.16	1.65	···	
38	9P/Tempel 1	P	Minor body	Sun	3.15 AU	0.510	10.47	3.15	0.53	···	
39	95P/Chiron	PS	Minor body	Sun	13.69 AU	0.379	6.94	13.69	7.50	···	
40	153P/Ikeya-Zhang	P	Minor body	Sun	51.12 AU	0.990	28.12	51.12	0.33	···	
41	(24835) 1995 SM_{55}	P	Minor body	Sun	41.66 AU	0.101	27.04	41.66	36.60	···	
42	(15788) 1993 SB	P	Minor body	Sun	39.15 AU	0.317	1.94	39.15	25.80	···	
43	(385185) 1993 RO	P	Minor body	Sun	39.23 AU	0.199	3.71	39.23	30.40	···	
44	15760 Albion	P	Minor body	Sun	43.93 AU	0.071	2.18	43.93	39.80	···	
45	79360 Sila-Nunam	P	Minor body	Sun	43.64 AU	0.009	2.26	43.64	42.30	···	
46	2011 QF_{99}	P	Minor body	Sun	19.04 AU	0.175	10.82	19.04	14.70	···	
47	2001 QR_{322}	P	Minor body	Sun	30.23 AU	0.031	1.32	30.23	28.30	···	
48	(523899) 1997 CV_{29}	P	Minor body	Sun	42.06 AU	0.043	8.04	42.06	39.30	···	
49	(20161) 1996 TR_{66}	P	Minor body	Sun	47.96 AU	0.401	12.40	47.96	27.70	···	
50	(91554) 1999 RZ_{215}	P	Minor body	Sun	103.40 AU	0.701	25.46	103.40	29.90	···	1
51	(181902) 1999 RD_{215}	P	Minor body	Sun	123.24 AU	0.696	25.94	123.24	36.60	···	2
52	541132 Leleākūhonua	PS	Minor body	Sun	1085.46 AU	0.940	11.65	1085.46	64.20	···	3

Table E1 *continued*

Table E1 *(continued)*

ID	Name	Samples	Phyla	Primary	a	e	i	$a_\odot$ (AU)	MOID$_\oplus$ (AU)	Θ	Ref
53	Phobos	PS	Minor body	Mars	9.376 Mm	0.015	1.08	1.52	0.52	···	
54	Amalthea	P	Minor body	Jupiter	181.4 Mm	0.003	0.38	5.20	4.20	···	
55	Methone	P	Minor body	Saturn	194.4 Mm	0.000	0.01	9.54	8.54	···	
56	Himalia	P	Minor body	Jupiter	11.46 Gm	0.159	28.61	5.20	4.20	···	
57	Phoebe	P	Minor body	Saturn	12.95 Gm	0.163	175.24	9.54	8.54	···	
58	Helene	P	Minor body	Saturn	377.4 Mm	0.000	0.21	9.54	8.54	···	
59	Epimetheus	P	Minor body	Saturn	151.4 Mm	0.016	0.35	9.54	8.54	···	
60	2006 RH_{120}	P	Minor body	Sun	1.00 AU	0.035	1.09	1.00	0.00	···	4
61	Prometheus	P	Minor body	Saturn	139.4 Mm	0.002	0.01	9.54	8.54	···	
62	Hyperion	P	Minor body	Saturn	1.501 Gm	0.023	0.62	9.54	8.54	···	
64	Saturn	P	Minor body	Sun	9.54 AU	0.054	2.49	9.54	8.54	18.8″	
65	Neptune	P	Minor body, Giant planet	Sun	30.07 AU	0.009	1.77	30.07	29.10	2.3″	
66	L_5 Kordylewsky cloud	P	Minor body	Earth	384.4 Mm	···	···	1.00	0.00	···	
67	2I/Borisov	P	Minor body	Sun	-0.85 AU	3.356	44.05	-0.85	1.09	···	5
68	1I/‘Oumuamua	PA	Minor body	Sun	-1.27 AU	1.201	122.74	-1.27	0.10	···	6
80	Mercury	P	Solid planetoid	Sun	0.39 AU	0.206	7.00	0.39	0.61	11.0″	
82	Mars	P	Solid planetoid	Sun	1.52 AU	0.093	1.85	1.52	0.52	18.0″	
85	Venus	PS	Solid planetoid	Sun	0.72 AU	0.007	3.39	0.72	0.28	59.6″	
95	1 Ceres	PS	Solid planetoid	Sun	2.77 AU	0.076	10.59	2.77	1.59	0.8″	
96	136199 Eris	PS	Solid planetoid	Sun	67.86 AU	0.436	44.04	67.86	37.30	···	7
97	134340 Pluto	PS	Solid planetoid	Sun	39.45 AU	0.250	17.09	39.45	28.60	0.1″	
98	90377 Sedna	PS	Solid planetoid	Sun	484.44 AU	0.843	11.93	484.44	75.30	···	8
99	136472 Makemake	P	Solid planetoid	Sun	45.43 AU	0.161	28.98	45.43	37.20	···	
100	136108 Haumea	P	Solid planetoid	Sun	43.18 AU	0.195	28.21	43.18	33.80	···	9
101	Moon	PS	Solid planetoid	Earth	384.4 Mm	0.055	5.16	0.00	0.00	31.1′	
102	Titan	P	Solid planetoid	Saturn	1.222 Gm	0.029	0.31	9.54	8.54	0.8″	
103	Triton	P	Solid planetoid	Neptune	354.8 Mm	0.000	156.87	30.07	29.10	0.1″	
104	Europa	P	Solid planetoid	Jupiter	671.1 Mm	0.009	0.47	5.20	4.20	1.0″	
105	Callisto	P	Solid planetoid	Jupiter	1.883 Gm	0.007	0.19	5.20	4.20	1.6″	
106	Ganymede	PS	Solid planetoid	Jupiter	1.070 Gm	0.001	0.18	5.20	4.20	1.7″	
107	Enceladus	PS	Solid planetoid	Saturn	238.0 Mm	0.000	0.00	9.54	8.54	···	
108	Io	PS	Solid planetoid	Jupiter	421.8 Mm	0.004	0.04	5.20	4.20	1.2″	
113	Jupiter	PS	Giant planet	Sun	5.20 AU	0.048	1.30	5.20	4.20	45.9″	
150	Sun	P	Star	Milky Way	8 kpc	···	···	···	0.98	32.5′	
518	International Space Station	P	Technology	Earth	···	···	···	···	0.00	···	
519	TBD	P	Technology	Earth	···	···	···	···	0.00	···	
520	TBD	P	Technology	Earth	···	···	···	···	0.00	···	
521	TBD	P	Technology	Earth	···	···	···	···	0.00	···	
522	TBD	P	Technology	Earth	···	···	···	···	0.00	···	
523	TBD	P	Technology	Earth	···	···	···	···	0.00	···	
524	TBD	P	Technology	Earth	···	···	···	···	0.00	···	
525	*Voyager 1*	P	Technology	Milky Way	···	···	···	···	0.00	···	
526	*LightSail 2*	P	Technology	Earth	···	···	···	···	0.00	···	
527	Lincoln Calibration Sphere-1	P	Technology	Earth	···	···	···	···	0.00	···	
528	Vanguard I	P	Technology	Earth	···	···	···	···	0.00	···	
529	TBD	P	Technology		···	···	···	···	0.00	···	
530	1963-014G	P	Technology	Earth	···	···	···	···	0.00	···	
531	Cosmos 860 coolant (1976-103G)	P	Technology	Earth	···	···	···	···	0.00	···	
532	Tesla Roadster	P	Technology	Sun	1.33 AU	0.259	1.09	1.33	0.33	···	

Table E1 *continued*

Table E1 *(continued)*

ID	Name	Samples	Phyla	Primary	a	e	i	$a_{\odot}$ (AU)	$\text{MOID}_{\oplus}$ (AU)	Θ	Ref
533	Solar antipoint	P	Not real	(Sun)	···	···	···	···	0.00	···	
534	Earth-Moon L_5	P	Not real	Earth	···	···	···	1.00	0.00	···	
535	Earth-Sun L_4	P	Not real	Sun	···	···	···	1.00	0.00	···	
537	1173 Anchises	S	Minor body	Sun	5.29 AU	0.139	6.92	5.29	3.55	···	
538	(55636) 2002 TX_{300}	S	Minor body	Sun	43.27 AU	0.126	25.83	43.27	42.30	···	
540	2019 LF_6	S	Minor body	Sun	0.56 AU	0.429	29.51	0.56	0.26	···	
541	2012 VP_{113}	S	Minor body	Sun	261.49 AU	0.693	24.11	261.49	79.50	···	
542	Proteus	S	Minor body	Neptune	117.6 Mm	0.001	0.08	30.07	29.10	···	
543	Neso	S	Minor body	Neptune	50.26 Gm	0.424	131.27	30.07	29.10	···	
544	Metis	S	Minor body	Jupiter	128.0 Mm	0.001	0.02	5.20	4.20	···	
546	Mimas	S	Solid planetoid	Saturn	185.5 Mm	0.020	1.57	9.54	8.54	···	
547	Iapetus	SA	Solid planetoid	Saturn	3.561 Gm	0.029	8.30	9.54	8.54	0.2″	
548	Tethys	S	Solid planetoid	Saturn	294.7 Mm	0.000	1.09	9.54	8.54	0.2″	
549	Charon	S	Solid planetoid	Pluto	19.59 Mm	0.000	0.08	39.48	38.50	···	
550	Miranda	S	Solid planetoid	Uranus	129.9 Mm	0.001	4.34	19.19	18.20	···	
675	17P/Holmes	A	Minor body	Sun	3.62 AU	0.432	19.09	3.62	1.06	···	
676	Uranus	A	Giant planet	Sun	19.19 AU	0.047	0.77	19.19	18.20	3.8″	
695	(10537) 1991 RY_{16}	A	Minor body	Sun	2.85 AU	0.071	7.26	2.85	1.63	···	

NOTE—**Name** – TBD refers to a type of technological object type whose Prototype is yet to be selected.
Samples – All samples a target is in. P: Prototype, S: Superlative, A: non-SETI Anomaly, E: SETI Anomaly, C: Control.
Primary – Name of body the target orbits.
a, e, i – Semimajor axis, eccentricity, inclination of target's orbit around body's primary, respectively.
$a_{\odot}$ – Semimajor axis of target's or primary's orbit around Sun.
$\text{MOID}_{\oplus}$ – Minimum orbital intersection distance with Earth's orbit.
Θ – Maximum angular size of body, as calculated from radius and $\text{MOID}_{\oplus}$.

References—(1) Chapman et al. (1995); Belton et al. (1996); (2) Brown (2020); (3) Brown (2020); (4) Buie et al. (2020); (5) Kwiatkowski et al. (2009); (6) Jewitt et al. (2020); (7) Meech et al. (2017); (8) Brown & Schaller (2007); (9) Pál et al. (2012); (10) Ragozzine & Brown (2009)

Table E2. The *Exotica Catalog*: Sidereal targets

ID	Name	Samples	Phyla	RA	Dec	D_L^{eff}	μ_α	μ_δ	Θ	I17?	Refs
35	β Pic	P	Minor body	5:47:17.1	-51:03:59	19.8 pc	4.7	83.1	···	✓	1
63	WD 1145+017	P	Minor body	11:48:33.6	+1:28:59	141.7 pc	-43.7	-4.1	···		2
69	TW Hya	P	Minor body, Star	11:01:51.9	-34:42:17	60.1 pc	-68.4	-14.0	···		3
70	EPIC 203937317	P	Minor body	16:26:17.1	-24:20:22	134.3 pc	-6.6	-27.1	···		4
71	GM Aur	P	Minor body	4:55:11.0	+30:21:59	159.6 pc	3.9	-24.5	···		5
72	τ Cet	P	Minor body, Star	1:44:04.1	-15:56:15	3.6 pc	-1721.0	854.2	···	✓	6
73	κ Psc	P	Minor body	23:26:56.0	+1:15:20	48.9 pc	87.1	-95.7	···	✓	7
74	Altair	P	Minor body	19:50:47.0	+8:52:06	5.1 pc	536.2	385.3	···	✓	8
75	NGC 2547 ID8	P	Minor body	8:09:02.5	-48:58:17	360.9 pc	-12.1	9.9	···		
76	BD+20 307	P	Minor body	1:54:50.3	+21:18:22	120.0 pc	38.8	-22.6	···		9
77	NGC 7293 central star	P	Minor body, Collapsed star	22:29:38.5	-20:50:14	201.0 pc	38.9	-3.4	···		10
78	G29-38	P	Minor body	23:28:47.6	+5:14:54	13.6 pc	-398.2	-266.7	···		11
79	WD J0914+1914	P	Minor body, Giant planet	9:14:05.3	+19:14:12	443.0 pc	-1.2	-11.6	···		12
81	K2-229 b	P	Solid planetoid	12:27:29.6	-6:43:19	102.8 pc	-80.9	7.4	···		13, 14
83	Kepler 444 d	PS	Solid planetoid	19:19:00.5	+41:38:05	36.5 pc	94.7	-632.2	···		15, 16
84	Proxima b	P	Solid planetoid	14:29:42.9	-62:40:46	1.3 pc	-3781.3	769.8	···	✓	17, 18

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
86	Kepler 78 b	P	Solid planetoid	19:34:58.0	+44:26:54	124.8 pc	38.1	-16.1	···		19
87	Barnard's star b	P	Solid planetoid	17:57:48.5	+4:41:36	1.8 pc	-802.8	10363.0	···	✓	20, 21
88	LHS 1140 b	PE	Solid planetoid, Star	0:44:59.3	-15:16:18	15.0 pc	317.6	-596.6	···		22, 23
89	HD 40307 f	P	Solid planetoid	5:54:04.2	-60:01:24	12.9 pc	-52.4	-60.2	···	✓	24, 25
90	55 Cnc e	P	Solid planetoid	8:52:35.8	+28:19:51	12.6 pc	-485.9	-233.7	···	✓	26, 27
91	TRAPPIST-1 bcdefg	PSE	Solid planetoid, Star	23:06:29.4	-5:02:29	12.4 pc	930.9	-479.4	···		28, 29
92	TOI 849 b	P	Solid planetoid	1:54:51.7	-29:25:18	227.2 pc	73.3	20.7	···		30, 31
93	KIC 12557548 b	P	Solid planetoid	19:23:51.9	+51:30:17	618.5 pc	0.3	11.1	···		32
94	PSR B1257+12 ABC	PSA	Solid planetoid	13:00:03.1	+12:40:55	600.0 pc	46.4	-84.9	···		33
109	Kepler 22 b	P	Giant planet	19:16:52.2	+47:53:04	195.7 pc	-39.7	-66.7	···		34
110	GJ 436 b	P	Giant planet	11:42:11.1	+26:42:24	9.8 pc	895.0	-814.0	···		35, 36, 37
111	HATS-P-26 b	P	Giant planet	14:12:37.5	+4:03:36	142.4 pc	37.8	-142.9	···		38
112	GJ 1214 b	P	Giant planet	17:15:18.9	+4:57:50	14.6 pc	580.4	-749.6	···		39, 40
114	HD 93083 b	P	Giant planet	10:44:20.9	-33:34:37	28.5 pc	-92.7	-152.2	···		41, 42, 43
115	HATS-17 b	P	Giant planet	12:48:45.5	-47:36:49	404.6 pc	-32.1	2.8	···		44, 45
116	HD 189733 b	P	Giant planet	20:00:43.7	+22:42:39	19.8 pc	-3.3	-250.2	···	✓	46, 47
117	HD 209458 b	P	Giant planet	22:03:10.8	+18:53:04	48.4 pc	29.6	-17.9	···		48, 49
118	Kepler 18 d	P	Giant planet	19:52:19.1	+44:44:47	438.5 pc	-1.4	-20.3	···		50, 51
119	HR 8799 bcde	P	Giant planet	23:07:28.7	+21:08:03	41.3 pc	108.3	-49.5	···	✓	52, 53
120	HD 28185 b	P	Giant planet	4:26:26.3	-10:33:03	39.4 pc	84.1	-59.8	···		54, 55
121	HD 80606 b	P	Giant planet	9:22:37.6	+50:36:13	66.6 pc	55.9	10.3	···		56, 57
122	HD 147506 b	P	Giant planet	16:20:36.4	+41:02:53	128.2 pc	-10.3	-29.2	···		58, 59
123	Pollux b	P	Giant planet	7:45:18.9	+28:01:34	10.4 pc	-626.5	-45.8	···	✓	60, 61
124	PSR B1620-26 (AB) b	PS	Giant planet	16:23:38.2	-26:31:54	2.2 kpc	···	···	···		62
125	Kepler 16 b	P	Giant planet	19:16:18.2	+51:45:27	75.2 pc	14.0	-48.6	···		63, 64
126	NN Ser cd	P	Giant planet	15:52:56.1	+12:54:44	521.8 pc	-30.1	-59.3	···		
127	Kepler 223 bcde	P	Giant planet	19:53:16.4	+47:16:46	2.0 kpc	-4.3	-11.1	···		
128	IRAS 16293-2422	P	Star	16:32:22.6	-24:28:32	120.0 pc	···	···	···		65, 66
129	Elias 29	P	Star	16:27:09.4	-24:37:19	120.0 pc	···	···	···		67
130	IRAS 20126+4104	P	Star	20:14:25.9	+41:13:37	1.4 kpc	-3.9	-4.6	···		
131	AB Aur	P	Star	4:55:45.8	+30:33:04	162.9 pc	3.9	-24.1	···		68
132	FU Ori	P	Star	5:45:22.4	+9:04:12	416.2 pc	2.2	-2.8	···		
133	WISE J085510.83-071442.5	PS	Star	8:55:10.8	-7:14:43	2.2 pc	-4800.0	500.0	···		69, 70
134	WISE J071322.55-291751.9	P	Star	7:13:22.6	-29:17:52	9.9 pc	341.1	-411.1	···		71

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
135	2MASSI J0415195-093506	P	Star	4:15:19.5	-9:35:07	5.6 pc	2193.0	527.0	···		72
136	ϵ Ind Bb	P	Star	22:04:10.5	-56:46:58	3.6 pc	3955.6	-2464.3	···		73
137	Luhman 16B	P	Star	10:49:18.9	-53:19:09	2.0 pc	···	···	···		74, 75
138	Luhman 16A	P	Star	10:49:19.0	-53:19:10	2.0 pc	···	···	···		76, 77
139	HD 130948BC	P	Star	14:50:16.0	+23:54:42	17.9 pc	144.7	32.4	···	✓	78
140	2MASSI J1506544+132106	P	Star	15:06:54.3	+13:21:06	11.7 pc	-1071.0	-11.9	···		79
141	PPL 15	P	Star	3:48:04.7	+23:39:30	142.1 pc	18.8	-45.5	···		80
142	2MASS J0523-1403	PS	Star	5:23:38.2	-14:03:02	12.8 pc	107.3	160.9	···		81
143	VB 10	P	Star	19:16:57.6	+5:09:02	5.9 pc	-598.2	-1365.3	···		82, 83
144	Wolf 359	P	Star	10:56:28.8	+7:00:52	2.0 pc	-3808.1	-2692.6	···	✓	84
145	HD 95735	P	Star	11:03:20.2	+35:58:12	2.5 pc	-580.3	-4765.9	···	✓	85
146	61 Cyg B	P	Star	21:06:55.3	+38:44:31	3.5 pc	4105.8	3155.8	···	✓	86
147	61 Cyg A	P	Star	21:06:53.9	+38:44:58	3.5 pc	4164.2	3250.0	···	✓	87
148	ϵ Eri	P	Star	3:32:55.8	-9:27:30	3.2 pc	-975.2	19.5	···	✓	88
149	κ_1 Cet	P	Star	3:19:21.7	+3:22:13	9.1 pc	269.3	93.8	···	✓	89
151	β Vir	P	Star	11:50:41.7	+1:45:53	11.1 pc	740.2	-270.4	···	✓	90
152	π_3 Ori	P	Star	4:49:50.4	+6:57:41	8.0 pc	464.1	11.2	···	✓	91
153	78 UMa	P	Star	13:00:43.7	+56:21:59	25.4 pc	107.9	2.0	···	✓	92
154	α Cep	P	Star	21:18:34.8	+62:35:08	15.0 pc	150.6	49.1	···	✓	93
155	Alcor	P	Star	13:25:13.5	+54:59:17	24.7 pc	120.2	-16.0	···	✓	94
156	Vega	P	Star	18:36:56.3	+38:47:01	7.7 pc	200.9	286.2	···	✓	95
157	λ Aql	P	Star	19:06:14.9	-4:52:57	37.0 pc	-20.1	-89.1	···	✓	96
158	α Gru	P	Star	22:08:14.0	-46:57:40	31.0 pc	126.7	-147.5	···	✓	97
159	η UMa	P	Star	13:47:32.4	+49:18:48	31.9 pc	-121.2	-14.9	···	✓	98
160	10 Lac	P	Star	22:39:15.7	+39:03:01	358.7 pc	-0.3	-5.5	···		99
161	HD 46150	P	Star	6:31:55.5	+4:56:34	1.5 kpc	-2.1	-0.6	···		100
162	HD 64568	P	Star	7:53:38.2	-26:14:03	7.1 kpc	-0.6	3.8	···		101
163	κ CrB	P	Star	15:51:13.9	+35:39:27	30.1 pc	-8.8	-347.8	···	✓	102, 103
164	μ Her	P	Star	17:46:27.5	+27:43:14	8.4 pc	-291.7	-749.6	···	✓	104
165	Procyon A	P	Star	7:39:18.1	+5:13:30	3.5 pc	-714.6	-1036.8	···	✓	105
166	ι UMa	P	Star	8:59:12.5	+48:02:31	14.5 pc	-441.3	-215.3	···	✓	106
167	γ Cru	P	Star	12:31:10.0	-57:06:48	27.2 pc	28.2	-265.1	···	✓	107
168	Aldebaran	P	Star	4:35:55.2	+16:30:33	20.4 pc	63.5	-188.9	···	✓	108
169	Arcturus	P	Star	14:15:39.7	+19:10:57	11.3 pc	-1093.4	-2000.1	···	✓	109
170	α Ser	P	Star	15:44:16.1	+6:25:32	25.4 pc	133.8	44.8	···	✓	110
171	BD +17 3248	P	Star	17:28:14.5	+17:30:36	819.1 pc	-47.7	-22.4	···		111
172	RR Lyr	P	Star	19:25:27.9	+42:47:04	265.2 pc	-109.1	-195.5	···		112, 113
173	HD 161817	P	Star	17:46:40.6	+25:44:57	187.8 pc	-37.7	-43.6	···		114
174	R Dor	P	Star	4:36:45.6	-62:04:38	54.6 pc	-69.4	-75.8	···		115
175	RS Cnc	P	Star	9:10:38.8	+30:57:47	143.5 pc	-11.1	-33.4	···		116
176	IRC +10216	P	Star	9:47:57.4	+13:16:44	92.7 pc	33.8	10.0	···		117
177	IRC +10011	P	Star	1:06:26.0	+12:35:53	500.0 pc	···	···	···		118, 119
178	HD 44179	P	Star	6:19:58.2	-10:38:15	440.5 pc	-6.5	-22.7	···		120
179	V4334 Sgr	P	Star	17:52:32.7	-17:41:08	2.9 kpc	···	···	···		121
180	Regulus	P	Star	10:08:22.3	+11:58:02	23.8 pc	-248.7	5.6	···	✓	122
181	Capella Ab	P	Star	5:16:41.4	+45:59:53	13.0 pc	75.2	-426.9	···		123
182	α Hya	P	Star	9:27:35.2	-8:39:31	55.3 pc	-15.2	34.4	···		124
183	α Cet	P	Star	3:02:16.8	+4:05:23	76.4 pc	-10.4	-76.8	···		125, 126

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
184	ζ Aur	P	Star	5:02:28.7	+41:04:33	241.0 pc	9.4	-20.7	···		127
185	ϵ Vir	P	Star	13:02:10.6	+10:57:33	32.7 pc	-273.8	20.0	···	✓	128
186	Capella Aa	P	Star	5:16:41.4	+45:59:53	13.0 pc	75.2	-426.9	···		129
187	δ Cep	P	Star	22:29:10.3	+58:24:55	244.0 pc	15.3	3.5	···		130
188	β Ara	P	Star	17:25:18.0	-55:31:48	198.0 pc	-8.5	-25.2	···		131
189	l Car	P	Star	9:45:14.8	-62:30:28	478.5 pc	-12.9	8.2	···		132
190	Canopus	P	Star	6:23:57.1	-52:41:44	94.8 pc	19.9	23.2	···		133
191	MSX SMC 055	P	Star	0:50:07.2	-73:31:25	61.9 kpc	···	···	···		134, 135
192	ι Ori AB	P	Star	5:35:26.0	-5:54:36	714.3 pc	1.4	-0.5	···		136
193	ζ Per	P	Star	3:54:07.9	+31:53:01	400.0 pc	5.8	-9.9	···		137
194	Deneb	P	Star	20:41:25.9	+45:16:49	432.9 pc	2.0	1.9	···		138
195	Betelgeuse	P	Star	5:55:10.3	+7:24:25	152.7 pc	27.5	11.3	···		139
196	ρ Cas	P	Star	23:54:23.0	+57:29:58	1.1 kpc	-5.4	-2.6	···		140
197	VY CMa	P	Star	7:22:58.3	-25:46:03	1.2 kpc	5.7	-6.8	···		141, 142, 143
198	EZ CMa	P	Star	6:54:13.0	-23:55:42	838.0 pc	-4.4	2.9	···		144, 145
199	γ_2 Vel	P	Star	8:09:32.0	-47:20:12	157.0 pc	-6.1	10.4	···		146
200	WR 102	PS	Star	17:45:47.5	-26:10:27	2.9 kpc	0.9	-0.2	···		147
201	ζ_1 Sco	P	Star	16:53:59.7	-42:21:43	1.6 kpc	0.0	-2.9	···		148
202	AG Car	P	Star	10:56:11.6	-60:27:13	1.3 kpc	-4.7	1.9	···		149
203	η Car	P	Star	10:45:03.5	-59:41:04	2.4 kpc	-11.0	4.1	···		150, 151, 152
204	ϵ Ser	P	Star	15:50:49.0	+4:28:40	20.8 pc	128.2	62.2	···	✓	153
205	α_2 CVn	P	Star	12:56:01.7	+38:19:06	35.2 pc	-235.1	53.5	···	✓	154
206	α And A	P	Star	0:08:23.3	+29:05:26	29.7 pc	137.5	-163.4	···	✓	
207	λ Boo	PA	Star	14:16:23.0	+46:05:18	30.3 pc	-187.3	159.1	···	✓	155
208	2MASS J0532+8246	P	Star	5:32:54.4	+82:46:45	24.9 pc	2038.3	-1663.7	···		156
209	Kapteyn's star	P	Star	5:11:40.6	-45:01:06	3.9 pc	6491.5	-5709.2	···	✓	157
210	Groombridge 1830	P	Star	11:52:58.8	+37:43:07	9.2 pc	4002.6	-5817.9	···		158
211	BD -00 4470	P	Star	23:09:32.9	+0:42:40	75.1 pc	-221.3	-1295.6	···		159
212	HD 84937	P	Star	9:48:56.1	+13:44:39	72.8 pc	373.1	-774.4	···		160
213	HD 140283	PS	Star	15:43:03.1	-10:56:01	62.1 pc	-1114.9	-303.6	···		161
214	HD 122563	P	Star	14:02:31.8	+9:41:10	290.4 pc	-189.7	-70.3	···		162
215	HE 0107-5240	P	Star	1:09:29.2	-52:24:34	12.5 kpc	2.4	-3.7	···		163
216	Mira A	P	Star, Interacting binary star	2:19:20.8	-2:58:39	91.7 pc	9.3	-237.4	···		164
217	δ Sct	P	Star	18:42:16.4	-9:03:09	61.1 pc	7.2	2.0	···		
218	γ Dor	P	Star	4:16:01.6	-51:29:12	20.5 pc	99.5	183.4	···	✓	165
219	53 Per	P	Star	4:21:33.2	+46:29:56	145.9 pc	21.5	-34.8	···		166
220	β Cep	P	Star	21:28:39.6	+70:33:39	210.1 pc	12.5	8.4	···		167
221	OGLE BLAP-009	P	Star	17:58:48.2	-27:16:54	2.6 kpc	-3.1	-4.3	···		168
222	PG 1716+426	P	Star	17:18:03.9	+42:34:13	877.2 pc	6.4	-22.6	···		169
223	V361 Hya	P	Star	14:05:33.0	-27:01:34	···	···	···	···		170
224	SDSS J160043.6+074802.9	P	Star	16:00:43.6	+7:48:03	5.3 kpc	1.4	-14.3	···		171
225	UV Cet	P	Star	1:39:01.6	-17:57:01	2.7 pc	3182.7	592.1	···	✓	172
226	HR 1099	P	Star	3:36:47.3	+0:35:16	29.6 pc	-32.9	-161.8	···	✓	
227	TVLM 513-46546	P	Star	15:01:08.2	+22:50:02	10.7 pc	-43.8	-64.0	···		173
228	CU Vir	P	Star	14:12:15.8	+2:24:34	71.8 pc	-42.6	-26.7	···		174
229	ζ Tau	P	Star	5:37:38.7	+21:08:33	136.4 pc	1.8	-20.1	···		
230	V838 Mon	P	Star	7:04:04.8	-3:50:51	6.1 kpc	-0.5	0.1	···		175, 176

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
231	M67-S1237	P	Star	8:51:50.2	+11:46:07	915.8 pc	-11.2	-2.9	···		177
232	FK Com	P	Star	13:30:46.8	+24:13:58	216.9 pc	-52.0	-22.3	···		178, 179
233	R CrB	P	Star	15:48:34.4	+28:09:24	1.3 kpc	-2.4	-11.8	···		180, 181
234	HD 124448	P	Star	14:14:58.6	-46:17:19	1.8 kpc	-6.9	-0.1	···		182
235	40 Cnc	P	Star	8:40:11.5	+19:58:16	192.1 pc	-35.3	-13.6	···		183
236	HD 149382	P	Star	16:34:23.3	-4:00:52	76.8 pc	-6.1	-5.5	···		184
237	BD+28 4211	P	Star	21:51:11.0	+28:51:50	113.6 pc	-34.7	-56.9	···		185
238	PG 1544+488	P	Star	15:46:11.7	+48:38:37	451.6 pc	-44.2	31.1	···		186
239	G77-61	P	Star	3:32:38.1	+1:58:00	78.6 pc	194.1	-749.5	···		187
240	ζ Oph	P	Star	16:37:09.5	-10:34:02	222.0 pc	15.3	24.8	···		188
241	HD 271791	P	Star	6:08:14.5	-71:23:07	1.1 kpc	-3.2	3.3	···		189
242	HVS 1	P	Star	9:07:45.0	+2:45:07	110.0 kpc	···	···	···		190
243	NLTT 11748	PS	Collapsed star	3:45:16.8	+17:48:09	134.0 pc	234.2	-178.3	···		191
244	LAWD 32	P	Collapsed star	9:46:39.1	+43:54:52	34.2 pc	-2.5	286.9	···		192
245	van Maanen 2	P	Collapsed star	0:49:09.9	+5:23:19	4.3 pc	1231.3	-2711.8	···		193
246	Sirius B	P	Collapsed star	6:45:09.3	-16:43:01	2.7 pc	-459.7	-915.0	···	✓	194
247	GD 50	P	Collapsed star	3:48:50.2	+0:58:32	31.2 pc	84.4	-163.0	···		
248	PG 1159-035	P	Collapsed star	12:01:46.0	-3:45:41	551.5 pc	-14.2	-3.3	···		195
249	GD 492	P	Collapsed star	14:06:35.4	+74:18:58	632.0 pc	-49.5	148.6	···		196
250	D6-3	PS	Collapsed star	18:52:01.9	+62:02:07	2.3 kpc	9.0	211.5	···		197
251	QU Vul	P	Collapsed star	20:26:45.9	+27:50:42	2.4 kpc	···	···	···		198
252	G191-B2B	P	Collapsed star	5:05:30.6	+52:49:52	52.9 pc	12.6	-93.5	···		199
253	LHS 253	P	Collapsed star	8:41:32.4	-32:56:33	8.5 pc	-1061.3	1345.9	···		200
254	GD 358	P	Collapsed star	16:47:18.4	+32:28:33	36.6 pc	-159.1	25.3	···		201
255	LAWD 87	P	Collapsed star	21:32:16.2	+0:15:14	42.7 pc	413.2	27.3	···		202
256	Stein 2051B	P	Collapsed star	4:31:12.6	+58:58:41	5.5 pc	1335.0	-1947.6	···		203
257	LAWD 37	P	Collapsed star	11:45:42.9	-64:50:29	4.6 pc	2661.6	-344.8	···		204
258	HZ 21	P	Collapsed star	12:13:56.3	+32:56:31	158.2 pc	-100.9	30.1	···		205
259	WD 1150+012	P	Collapsed star	11:53:05.5	+0:56:46	158.3 pc	-141.1	-45.3	···		206
260	SDSS 1102+2054	P	Collapsed star	11:02:39.8	+20:54:40	73.0 pc	-157.9	-41.7	···		207
261	Grw +70°8247	P	Collapsed star	19:00:10.3	+70:39:51	13.0 pc	85.8	505.1	···		208
262	ZZ Cet	P	Collapsed star	1:36:13.6	-11:20:33	32.8 pc	460.8	-116.4	···		209
263	Ton 124	P	Collapsed star	12:45:35.6	+42:38:25	71.0 pc	19.1	-54.1	···		210, 211
264	1E 1207.4-5209	P	Collapsed star	12:10:00.9	-52:26:28	2.1 kpc	···	···	···		212
265	Geminga	P	Collapsed star	6:33:54.2	+17:46:13	250.0 pc	···	···	···		213
266	Crab pulsar	P	Collapsed star	5:34:31.9	+22:00:52	2.0 kpc	···	···	···		
267	SGR 1806-20	PS	Collapsed star	18:08:39.3	-20:24:40	15.1 kpc	···	···	···		
268	XTE J1810-197	P	Collapsed star	18:09:51.1	-19:43:52	3.3 kpc	···	···	···		214
269	SGR 1935+2154	PA	Collapsed star	19:34:55.7	+21:53:48	9.5 kpc	···	···	···		215
270	PSR B0656+14	P	Collapsed star	6:59:48.2	+14:14:22	288.2 pc	···	···	···		216
271	RX J1856.5-3754	P	Collapsed star	18:56:35.1	-37:54:30	123.0 pc	326.7	-59.1	···		
272	PSR J0437-4715	P	Collapsed star, Stellar group	4:37:15.8	-47:15:09	120.1 pc	122.9	-71.2	···		
273	Cygnus X-1	P	Collapsed star, Interacting binary star	19:58:21.7	+35:12:06	2.4 kpc	-3.9	-6.2	···		
274	NGC 3201 BH1	P	Collapsed star	10:17:37.1	-46:24:55	7.7 kpc	10.3	-2.8	···		
275	NGC 6946-BH1	PA	Star, Collapsed star	20:35:27.6	+60:08:08	7.7 Mpc	···	···	···		217
276	Algol	P	Interacting binary star	3:08:10.1	+40:57:20	27.6 pc	3.0	-1.7	···	✓	
277	W UMa	P	Interacting binary star	9:43:45.5	+55:57:09	51.9 pc	17.1	-29.2	···		

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
278	FG Hya	P	Interacting binary star	8:27:03.9	+3:30:52	153.7 pc	3.6	-64.1	···		
279	OO Aql	P	Interacting binary star	19:48:12.7	+9:18:32	119.2 pc	65.5	-7.2	···		
280	CH Cyg	P	Interacting binary star	19:24:33.1	+50:14:29	183.0 pc	-8.3	-11.4	···		
281	R Aqr	P	Interacting binary star	23:43:49.5	-15:17:04	320.3 pc	27.3	-29.9	···		
282	RR Tel	P	Interacting binary star	20:04:18.5	-55:43:33	3.5 kpc	3.3	-3.2	···		218
283	RS Oph	P	Interacting binary star	17:50:13.2	-6:42:28	2.3 kpc	1.2	-5.9	···		
284	SS Cyg	P	Interacting binary star	21:42:42.8	+43:35:10	114.6 pc	112.4	33.6	···		
285	UX UMa	P	Interacting binary star	13:36:41.0	+51:54:49	297.6 pc	-41.7	17.1	···		
286	T Pyx	P	Interacting binary star	9:04:41.5	-32:22:48	3.2 kpc	-2.5	0.2	···		
287	GK Per	P	Interacting binary star	3:31:12.0	+43:54:15	441.9 pc	-6.7	-17.2	···		
288	DQ Her	P	Interacting binary star	18:07:30.3	+45:51:33	500.6 pc	-0.9	12.4	···		
289	AE Aqr	P	Interacting binary star	20:40:09.2	+0:52:15	91.2 pc	70.6	13.1	···		
290	AM Her	P	Interacting binary star	18:16:13.3	+49:52:05	87.8 pc	-46.0	28.0	···		
291	AR Sco	P	Interacting binary star	16:21:47.3	-22:53:10	117.8 pc	9.7	-51.5	···		
292	AM CVn	P	Interacting binary star	12:34:54.6	+37:37:44	298.4 pc	30.9	12.4	···		
293	QR And	P	Interacting binary star	0:19:49.9	+21:56:52	2.0 kpc	18.5	-5.5	···		
294	Sco X-1	P	Interacting binary star	16:19:55.1	-15:38:25	2.8 kpc	-6.8	-12.2	···		
295	4U 1608-52	P	Interacting binary star	16:12:43.0	-52:25:23	3.3 kpc	···	···	···		
296	4U 1730-335	P	Interacting binary star	17:33:24.6	-33:23:20	8.8 kpc	···	···	···		
297	4U 1820-303	P	Interacting binary star	18:23:40.6	-30:21:41	7.6 kpc	···	···	···		
298	GX 1+4	P	Interacting binary star	17:32:02.2	-24:44:44	4.5 kpc	-4.6	-2.2	···		
299	SAX J1808.4-3658	P	Interacting binary star	18:08:27.5	-36:58:44	3.5 kpc	···	···	···		219
300	PSR J1023+0038	P	Interacting binary star	10:23:47.7	+0:38:41	1.4 kpc	4.8	-17.3	···		
301	Her X-1	P	Interacting binary star	16:57:49.8	+35:20:32	6.6 kpc	-1.3	-7.9	···		
302	A 0535+26	P	Interacting binary star	5:38:54.6	+26:18:57	2.0 kpc	-0.6	-2.8	···		
303	Vela X-1	P	Interacting binary star	9:02:06.9	-40:33:17	2.6 kpc	-5.0	9.1	···		
304	Cen X-3	P	Interacting binary star	11:21:15.1	-60:37:26	10.0 kpc	-3.1	2.1	···		
305	4U 1954+31	P	Interacting binary star	19:55:42.3	+32:05:49	1.7 kpc	-1.9	-5.7	···		
306	V404 Cyg	P	Interacting binary star	20:24:03.8	+33:52:02	2.4 kpc	···	···	···		220
307	MCW 656	P	Interacting binary star	18:18:36.4	-13:48:02	2.6 kpc	0.1	2.1	···		221
308	GRS 1915+105	P	Interacting binary star	19:15:11.5	+10:56:45	11.0 kpc	···	···	···		
309	SS433	P	Interacting binary star	19:11:49.6	+4:58:58	4.5 kpc	-2.9	-4.6	···		222

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
310	M82 X-1	P	Interacting binary star	9:55:50.0	+69:40:46	3.4 Mpc	···	···	···		223
311	M101 ULX-1	P	Interacting binary star	14:03:32.4	+54:21:03	6.5 Mpc	···	···	···		224
312	M82 X-2	P	Interacting binary star	9:55:51.0	+69:40:45	3.4 Mpc	···	···	···		225
313	RZ 2109 ULX	P	Interacting binary star	12:29:39.7	+7:53:31	···	···	···	···		
314	γ Cas	P	Interacting binary star	0:56:42.5	+60:43:00	117.0 pc	25.6	-3.8	···		
315	IGR J17544-2619	P	Interacting binary star	17:54:25.3	-26:19:53	3.2 kpc	-0.7	-0.5	···		
316	WR 140	P	Interacting binary star	20:20:28.0	+43:51:16	1.7 kpc	-4.7	-2.0	···		
317	XX Oph	P	Interacting binary star	17:43:56.5	-6:16:09	735.8 pc	0.8	-3.5	···		
318	PSR B1259-63	P	Interacting binary star	13:02:47.7	-63:50:09	2.4 kpc	-7.0	-0.4	···		
319	PSR B1957+20	PS	Collapsed star, Interacting binary star	19:59:36.7	+20:48:15	2.5 kpc	-16.0	-26.0	···		226
320	PSR J1417-4402	P	Interacting binary star	14:17:30.6	-44:02:57	3.1 kpc	···	···	···		227
321	α Cen AB	P	Stellar group	14:39:29.7	-60:49:56	1.3 pc	-3608.0	686.0	···	✓	228
322	T Tau	P	Stellar group	4:21:59.4	+19:32:06	144.3 pc	11.4	-14.8	···		229
323	Luhman 16	P	Stellar group	10:49:18.9	-53:19:10	2.0 pc	-2759.0	354.0	···		
324	WD 0135-052	P	Stellar group	1:37:59.4	-4:59:45	12.6 pc	580.9	-350.2	···		230
325	PSR J1719-1438	P	Stellar group	17:19:10.1	-14:38:01	1.2 kpc	···	···	···		231
326	PSR B1913+16	P	Stellar group	19:15:28.0	+16:06:27	5.2 kpc	···	···	···		
327	HW Vir	P	Stellar group	12:44:20.2	-8:40:17	172.5 pc	9.0	-15.7	···		
328	KOI 54	P	Stellar group	19:46:15.5	+43:56:51	336.9 pc	17.5	5.1	···		232
329	YY Gem	P	Stellar group	7:34:37.4	+31:52:10	15.1 pc	-201.5	-97.1	···	✓	233
330	ϵ Aur	P	Stellar group	5:01:58.1	+43:49:24	414.9 pc	-0.9	-2.7	···		234
331	PSR J0737-3039	P	Stellar group	7:37:51.2	-30:39:41	1.1 kpc	···	···	···		235
332	KIC 8145411	PA	Stellar group	18:50:08.0	+44:04:25	···	···	···	···		236
333	RS CVn	P	Stellar group	13:10:36.9	+35:56:06	135.9 pc	-50.0	20.6	···		237
334	IC 2391	P	Stellar group	8:40:32.0	-53:02:00	176.0 pc	-24.9	23.3	···		
335	M67	P	Stellar group	8:51:18.0	+11:48:00	850.0 pc	-11.0	-2.9	$25.0' \times 25.0'$		
336	Westerlund 1	P	Stellar group	16:47:04.0	-45:51:05	4.0 kpc	-2.3	-3.7	$3.0' \times 3.0'$		
337	N1023-FF-14	P	Stellar group	2:40:19.6	+39:04:37	···	···	···	···		
338	47 Tuc	P	Stellar group	0:24:05.4	-72:04:53	4.5 kpc	5.2	-2.5	···		238, 239
339	M15	P	Stellar group	21:29:58.3	+12:10:01	10.4 kpc	-0.6	-3.8	···		240, 241
340	NGC 6752	PA	Stellar group	19:10:52.1	-59:59:04	4.0 kpc	-3.2	-4.0	···		242, 243
341	M31-EC4	P	Stellar group	0:58:15.4	+38:03:02	785.0 kpc	···	···	···		244
342	Palomar 1	P	Stellar group	3:33:20.0	+79:34:52	11.1 kpc	-0.2	0.0	···		245, 246
343	Central Cluster	P	Stellar group	17:45:40.0	-29:00:28	8.2 kpc	···	···	···		247
344	ω Cen	P	Stellar group	13:26:47.3	-47:28:46	5.2 kpc	-3.2	-6.7	$8.4' \times 8.4'$		248, 249
345	CMa R1	P	Stellar group	7:04	-11:30	690.0 pc	···	···	$200' \times < 1^\circ$		250
346	Cyg OB2	P	Stellar group	20:33:12.0	+41:19:00	1.5 kpc	-1.6	-4.7	···		
347	NGC 604	PS	Stellar group, ISM	1:34:32.1	+30:47:01	809.0 kpc	···	···	···		251
348	Cen A outer filament	P	Stellar group	13:26:28.1	-42:50:06	3.7 Mpc	···	···	$8'$		252
349	ζ Oph cloud	P	ISM	16:37:09.0	-10:34:00	150.0 pc	···	···	···		253

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
350	NGC 7023	P	ISM	21:01:36.9	+68:09:48	320.0 pc	···	···	···		254
351	Orion A	P	ISM	5:38:14.2	-7:07:08	400.0 pc	···	···	$7° \times 1°$		255
352	G028.37+00.07	P	ISM	18:42:50.6	-4:03:30	4.8 kpc	···	···	$6.3' \times 3.3'$		256
353	TMC-1	P	ISM	4:41:45.9	+25:41:27	140.0 pc	···	···	$15' \times 5'$		257
354	Barnard 68	P	ISM	17:22:38.2	-23:49:34	125.0 pc	···	···	···		258
355	Orion hot core	P	ISM	5:35:14.5	-5:22:30	418.0 pc	···	···	···		259
356	Sextans A hole	P	ISM	10:11:00.5	-4:41:30	1.4 Mpc	···	···	$3.6'$		260
357	M42	P	ISM	5:35:17.3	-5:23:28	500.0 pc	1.7	-0.3	$5.5' \times 5.5'$		
358	W3(OH)	P	ISM	2:27:04.1	+61:52:22	2.0 kpc	···	···	···		261
359	NGC 3603	P	ISM	11:15:18.6	-61:15:26	7.0 kpc	-5.5	2.0	···		262
360	Arp 220	P	ISM, Galaxy	15:34:57.2	+23:30:12	83.5 Mpc	···	···	$1.3' \times 52.2''$		263, 264
361	HH 1	P	ISM	5:36:20.8	-6:45:13	400.0 pc	···	···	···		265
362	EGO G16.59-0.05	P	ISM	18:21:09.2	-14:31:45	4.3 kpc	···	···	$46''$		266
363	ζ Oph bow shock	P	ISM	16:37:15.0	-10:30	112.2 pc	···	···	$1'$		
364	Red Rectangle nebula	P	ISM	6:19:58.2	-10:38:15	440.5 pc	-6.5	-22.7	···		
365	Helix Nebula	P	ISM	22:29:38.5	-20:50:14	201.0 pc	38.9	-3.4	$13.4' \times 13.4'$		
366	NGC 6302	P	ISM	17:13:44.3	-37:06:11	741.0 pc	···	···	$44.6'' \times 44.6''$		
367	NGC 2346	P	ISM	7:09:22.5	+0:48:24	1.5 kpc	-2.1	-1.2	$54.6'' \times 54.6''$		
368	IRC +10420	P	ISM	19:26:48.1	+11:21:17	1.7 kpc	-2.0	-7.4	···		
369	SBW 1	P	ISM	10:40:19.4	-59:49:10	7.7 kpc	-5.6	2.7	···		
370	Homunculus Nebula	P	ISM	10:45:03.5	-59:41:04	2.4 kpc	···	···	···		267
371	S 308	P	ISM	6:54:13.0	-23:55:42	838.0 pc	-4.4	2.9	···		
372	Cas A	P	ISM	23:23:24.0	+58:48:54	3.4 kpc	···	···	$5.0' \times 5.0'$		
373	Kes 75	P	ISM	18:46:25.5	-2:59:14	5.8 kpc	···	···	$3.0' \times 3.0'$		268
374	W44	P	ISM	18:56:10.7	+1:13:21	3.0 kpc	···	···	$35.0' \times 27.0'$		269
375	SN 1987A	P	ISM	5:35:28.0	-69:16:11	49.6 kpc	···	···	$1.8'' \times 1.8''$		270
376	Crab Nebula	P	ISM	5:34:31.9	+22:00:52	2.0 kpc	···	···	$7.0' \times 5.0'$		
377	SWIFT J1834.9-0846 nebula	P	ISM	18:34:52.8	-8:45:41	4.0 kpc	···	···	$37.5''$		271
378	PSR B1957+20 bow shock	P	ISM	19:59:36.7	+20:48:15	2.5 kpc	-16.0	-26.0	···		272
379	Geminga halo	P	ISM	6:33:55.0	+17:46:11	250.0 pc	···	···	$5.5°$		273
380	R Aqr nebula	P	ISM	23:43:49.5	-15:17:04	320.3 pc	···	···	···		
381	GK Per shell	P	ISM	3:31:11.9	+43:54:15	441.9 pc	···	···	$1.0' \times 49.9''$		
382	CAL 83 nebula	P	ISM	5:43:34.2	-68:22:22	49.6 kpc	1.6	0.5	···		274
383	SAX J1712.6-3739 nebula	P	ISM	17:12:34.6	-37:39:00	6.9 kpc	···	···	···		
384	Cygnus X-1 shell	P	ISM	19:58:21.7	+35:12:06	2.4 kpc	···	···	$6.07' \times 4.50'$		275
385	N159F	P	ISM	5:39:38.8	-69:44:36	55.0 kpc	1.8	0.7	···		276
386	W50	P	ISM	19:12:20.0	+4:55:00	4.5 kpc	···	···	$2.0° \times 1.0°$		277
387	Cygnus Cocoon	P	ISM	20:28:39.7	+41:10:18	1.4 kpc	···	···	$2°$		278
388	HVC 125+41-208	P	ISM	12:24:00.0	+75:36:00	···	···	···	$1.3° \times 0.7°$		279
389	SSA22a-LAB01	P	ISM	22:17:26.1	+0:12:32	···	···	···	···		
390	NGC 6166	P	Galaxy	16:28:38.2	+39:33:04	124.7 Mpc	···	···	$1.1' \times 46.7''$		
391	NGC 4636	P	Galaxy	12:42:49.9	+2:41:16	15.1 Mpc	···	···	$7.8' \times 5.9'$		280
392	M59	P	Galaxy	12:42:02.3	+11:38:49	15.3 Mpc	···	···	$5.5' \times 4.0'$	✓	281
393	NGC 821	P	Galaxy	2:08:21.1	+10:59:42	23.2 Mpc	···	···	$1.9' \times 1.5'$	✓	
394	NGC 3115	P	Galaxy	10:05:14.0	-7:43:07	10.3 Mpc	···	···	$7.8' \times 4.0'$		282
395	NGC 4260	P	Galaxy	12:19:22.2	+6:05:56	37.7 Mpc	···	···	$1.9' \times 49.9''$		283
396	M32	P	Galaxy	0:42:41.8	+40:51:55	785.0 kpc	···	···	···		284, 285
397	NGC 4546 UCD-1	P	Galaxy	12:35:28.7	-3:47:21	···	···	···	···		286
398	NGC 205	P	Galaxy	0:40:22.1	+41:41:07	824.0 kpc	···	···	$18.6' \times 10.5'$		287, 288

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
399	Sculptor dSph	P	Galaxy	1:00:09.4	-33:42:32	90.0 kpc	···	···	$15.3' \times 15.3'$	✓	289
400	UMa II	P	Galaxy	8:51:30.0	+63:07:48	34.7 kpc	···	···	···		
401	NGC 4431	P	Galaxy	12:27:27.4	+12:17:25	17.3 Mpc	···	···	$55.8'' \times 34.6''$		
402	NGC 1277	P	Galaxy	3:19:51.5	+41:34:24	67.7 Mpc	···	···	$40.8'' \times 22.9''$		290
403	MRG-M0150	P	Galaxy	1:50:21.2	-10:05:30	···	···	···	···		291
404	MRG-M0138	P	Galaxy	1:38:03.9	-21:55:49	···	···	···	···		292
405	IC 976	P	Galaxy	14:08:43.3	-1:09:42	24.1 Mpc	···	···	$55.4'' \times 21.1''$		
406	NGC 404	P	Galaxy	1:09:27.1	+35:43:05	3.0 Mpc	···	···	$6.0' \times 6.0'$		293
407	M81	P	Galaxy	9:55:33.2	+69:03:55	3.7 Mpc	···	···	$21.4' \times 10.2'$	✓	294
408	M100	P	Galaxy	12:22:54.9	+15:49:20	13.9 Mpc	···	···	$7.6' \times 6.8'$		
409	D563-4	P	Galaxy	8:55:07.2	+19:45:04	···	···	···	$21.0'' \times 15.6''$		
410	NGC 891	P	Galaxy	2:22:32.9	+42:20:54	9.9 Mpc	···	···	$12.3' \times 2.5'$		295
411	Phoenix dwarf	P	Galaxy	1:51:06.3	-44:26:41	440.0 kpc	···	···	$4.9' \times 4.1'$	✓	296
412	NGC 5173	P	Galaxy	13:28:25.3	+46:35:30	38.4 Mpc	···	···	$36.8'' \times 32.4''$		297, 298
413	IC 225	P	Galaxy	2:26:28.3	+1:09:37	17.7 Mpc	···	···	$21.4'' \times 20.5''$		299, 300
414	M101	P	Galaxy	14:03:12.6	+54:20:56	6.5 Mpc	···	···	$21.9' \times 20.9'$	✓	301, 302
415	NGC 300	P	Galaxy	0:54:53.4	-37:41:03	2.0 Mpc	···	···	$20.9' \times 13.5'$		303
416	NGC 55	P	Galaxy	0:14:53.6	-39:11:48	2.1 Mpc	···	···	$32.4' \times 4.0'$		304
417	NGC 4701	P	Galaxy	12:49:11.6	+3:23:19	15.6 Mpc	···	···	$51.4'' \times 40.1''$		
418	SS 16	P	Galaxy	9:47:00.1	+25:40:46	···	···	···	$53.4'' \times 43.2''$		305, 306
419	M99	P	Galaxy	12:18:49.6	+14:24:59	13.9 Mpc	···	···	$5.1' \times 4.5'$		
420	NGC 4631	P	Galaxy	12:42:08.0	+32:32:29	7.3 Mpc	···	···	$13.5' \times 2.5'$		307
421	NGC 6822	P	Galaxy	19:44:56.2	-14:47:51	520.0 kpc	···	···	$13.8' \times 12.9'$	✓	308, 309
422	IC 1613	P	Galaxy	1:04:54.2	+2:08:00	760.0 kpc	···	···	$16.2' \times 14.5'$	✓	310, 311
423	NGC 3077	P	Galaxy	10:03:19.1	+68:44:02	3.8 Mpc	···	···	$2.4' \times 1.9'$		312, 313
424	SGAS J143845.1+145407	P	Galaxy	14:38:45.1	+14:54:07	···	···	···	···		314, 315
425	Sp1149 (A1)	P	Galaxy	11:49:35.3	+22:23:46	···	···	···	···		316, 317
426	A68-HLS115	P	Galaxy	0:37:09.5	+9:09:04	···	···	···	···		318, 319
427	HLock-01 (R)	P	Galaxy	10:57:51.1	+57:30:27	···	···	···	···		320, 321
428	M82	P	Galaxy	9:55:52.4	+69:40:47	3.4 Mpc	···	···	···		322, 323
429	Arp 236	P	Galaxy	1:07:47.2	-17:30:25	84.1 Mpc	···	···	···		324
430	HIZOA J0836-43	P	Galaxy	8:36:42.1	-43:38:07	···	···	···	···		325
431	I Zwicky 18	P	Galaxy	9:34:02.1	+55:14:25	13.0 Mpc	···	···	$2.0' \times 2.0'$		326
432	POX 186	PS	Galaxy	13:25:48.6	-11:36:38	···	···	···	···		
433	Haro 2	P	Galaxy	10:32:32.0	+54:24:04	15.4 Mpc	···	···	···		327, 328
434	NGC 2366	P	Galaxy	7:28:51.9	+69:12:31	3.3 Mpc	···	···	$8.1' \times 3.3'$		329
435	ID11	P	Galaxy	22:48:42.0	-44:32:28	···	···	···	···		330, 331
436	SL2S J02176-0513	P	Galaxy	2:17:37.1	-5:13:30	···	···	···	···		332, 333
437	cB 58	P	Galaxy	15:14:22.3	+36:36:26	···	···	···	···		334, 335
438	SMM J2135-0102	P	Galaxy	21:35:11.6	-1:02:52	···	···	···	···		336, 337
439	Minkowski's Object	P	Galaxy	1:25:47.0	-1:22:18	···	···	···	···		338
440	Malin 1	P	Galaxy	12:36:59.3	+14:19:49	···	···	···	$8.8'' \times 8.8''$		339

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
441	VCC 1287	P	Galaxy	12:30:23.8	+13:58:56	16.6 Mpc	···	···	45.6″ × 5.4″		340, 341
442	UGC 2162	P	Galaxy	2:40:24.6	+1:13:36	16.7 Mpc	···	···	1.4′ × 1.1′		342
443	HI 1232+20	P	Galaxy	12:32:00.0	+20:25:00	10.9 Mpc	···	···	···		343
444	Cartwheel galaxy	P	Galaxy	0:37:41.1	-33:42:59	125.0 Mpc	···	···	···		
445	NGC 4650A	P	Galaxy	12:44:49.0	-40:42:52	61.0 Mpc	···	···	31.2″ × 24.4″		344
446	Hoag's Object	P	Galaxy	15:17:14.4	+21:35:08	···	···	···	18.0″ × 12.0″		345
447	M51a/b	P	Galaxy	13:29:52.7	+47:11:43	7.6 Mpc	···	···	10.0′ × 7.6′	✓	
448	The Antennae	P	Galaxy	12:01:53.2	-18:52:38	23.3 Mpc	···	···	···		346
449	Antennae TDG	P	Galaxy	12:01:25.7	-19:00:42	···	···	···	···		
450	3C 75	P	Galaxy, AGN	2:57:41.6	+6:01:28	106.7 Mpc	···	···	44.5″ × 29.3″		
451	ESO 137-001	P	Galaxy	16:13:27.3	-60:45:51	···	···	···	21.4″ × 11.6″		
452	IC 3418	P	Galaxy	12:29:43.9	+11:24:17	17.0 Mpc	···	···	1.5′ × 1.0′		347
453	M51a	P	Galaxy	13:29:52.7	+47:11:43	7.6 Mpc	···	···	10.0′ × 7.6′	✓	348
454	NGC 7793	P	Galaxy	23:57:49.8	-32:35:28	3.6 Mpc	···	···	10.0′ × 6.0′	✓	349
455	NGC 4622	P	Galaxy	12:42:37.6	-40:44:39	61.9 Mpc	···	···	1.2′ × 59.0″		
456	M91	P	Galaxy	12:35:26.4	+14:29:47	17.1 Mpc	···	···	5.4′ × 4.5′		
457	NGC 1097	P	Galaxy	2:46:19.1	-30:16:30	15.8 Mpc	···	···	10.0′ × 6.2′		
458	M64	P	Galaxy	12:56:43.7	+21:40:58	4.4 Mpc	···	···	9.8′ × 4.9′	✓	350
459	NGC 1291	P	Galaxy	3:17:18.6	-41:06:29	11.2 Mpc	···	···	10.5′ × 8.1′		351
460	NGC 2787	P	Galaxy	9:19:18.6	+69:12:12	7.4 Mpc	···	···	2.5′ × 1.5′	✓	
461	NGC 1365	P	Galaxy, AGN	3:33:36.5	-36:08:26	17.0 Mpc	···	···	10.7′ × 6.3′		352
462	NGC 6012	P	Galaxy	15:54:13.9	+14:36:04	26.3 Mpc	···	···	1.4′ × 47.6″		
463	NGC 1433	P	Galaxy	3:42:01.6	-47:13:19	15.4 Mpc	···	···	6.3′ × 4.2′		
464	NGC 5101	P	Galaxy	13:21:46.2	-27:25:50	16.2 Mpc	···	···	5.6′ × 4.9′		
465	NGC 3898	P	Galaxy	11:49:15.4	+56:05:04	21.3 Mpc	···	···	3.8′ × 2.3′		
466	UGC 7321	P	Galaxy	12:17:34.0	+22:32:23	22.3 Mpc	···	···	5.1′ × 22.2″		353
467	NGC 3923	P	Galaxy	11:51:01.8	-28:48:22	20.5 Mpc	···	···	6.8′ × 4.5′		
468	LEDA 074886	P	Galaxy	3:40:43.2	-18:38:43	···	···	···	23.6″ × 14.2″		
469	KK 246	P	Galaxy	20:03:57.4	-31:40:53	6.8 Mpc	···	···	39.0″ × 16.8″		
470	ESO 243-49 HLX1	P	AGN	1:10:28.3	-46:04:22	···	···	···	···		
471	Sgr A*	P	AGN	17:45:40.0	-29:00:28	8.2 kpc	···	···	···		
472	NGC 1052	P	AGN	2:41:04.8	-8:15:21	19.2 Mpc	···	···	2.1′ × 1.6′	✓	
473	NGC 4395	P	AGN	12:25:48.9	+33:32:49	4.8 Mpc	···	···	11.5′ × 4.3′		
474	NGC 4686	P	AGN	12:46:39.8	+54:32:03	71.7 Mpc	···	···	1.8′ × 31.6″		
475	NGC 7469	P	AGN	23:03:15.7	+8:52:25	69.8 Mpc	···	···	1.4′ × 1.1′		
476	NGC 1068	P	AGN	2:42:40.8	+0:00:48	19.0 Mpc	···	···	6.9′ × 6.0′		
477	I Zwicky 1	P	AGN	0:53:34.9	+12:41:36	···	···	···	28.8″ × 21.0″		
478	NGC 2911	P	AGN	9:33:46.1	+10:09:09	47.8 Mpc	···	···	1.2′ × 58.1″		
479	Centaurus A	P	AGN	13:25:27.6	-43:01:09	3.7 Mpc	···	···	25.7′ × 17.8′		354
480	Cygnus A	P	AGN	19:59:28.4	+40:44:02	···	···	···	36.2″ × 30.4″		
481	NGC 1265	P	AGN	3:18:15.7	+41:51:28	···	···	···	1.8′ × 1.6′		
482	3C 403	P	AGN	19:52:15.8	+2:30:24	···	···	···	19.2″ × 14.2″		
483	3C 286	P	AGN	13:31:08.3	+30:30:33	···	···	···	···		
484	PKS 1934-638	P	AGN	19:39:25.0	-63:42:46	···	···	···	···		
485	3C 273	P	AGN	12:29:06.7	+2:03:09	657.8 Mpc	···	···	···		
486	Mrk 335	P	AGN	0:06:19.5	+20:12:11	109.5 Mpc	···	···	···		
487	Cloverleaf quasar	P	AGN	14:15:46.2	+11:29:43	···	···	···	···		355
488	PHL 1811	P	AGN	21:55:01.5	-9:22:24	···	···	···	···		
489	BL Lac	P	AGN	22:02:43.3	+42:16:40	···	···	···	0.0″ × 0.0″		
490	3C 279	P	AGN	12:56:11.2	-5:47:22	···	···	···	···		
491	TXS 0506+056	P	AGN	5:09:26.0	+5:41:35	···	···	···	0.0″ × 0.0″		
492	SST24 J143644.2+350627	P	AGN	14:36:44.2	+35:06:27	···	···	···	···		
493	WISE 1814+3412	P	AGN	18:14:17.3	+34:12:25	···	···	···	···		

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
494	NGC 4258	P	AGN	12:18:57.6	+47:18:13	7.7 Mpc	···	···	$17.8' \times 6.9'$	✓	
495	NGC 4151	P	AGN	12:10:32.6	+39:24:21	18.5 Mpc	···	···	$6.2' \times 4.8'$		
496	NGC 6240	P	AGN	16:52:58.9	+2:24:04	105.4 Mpc	···	···	$1.1' \times 37.1''$		
497	0402+379	P	AGN	4:05:49.3	+38:03:32	···	···	···	$35.8'' \times 21.5''$		
498	OJ 287	P	AGN	8:54:48.9	+20:06:31	1.3 Gpc	···	···	···		
499	Hanny's Voorwerp	P	AGN	9:41:03.8	+34:43:34	···	···	···	···		356
500	B2 0924+30	P	AGN	9:27:52.8	+29:59:09	···	···	···	$46.4'' \times 40.9''$		
501	Arp 294	P	Galaxy association	11:39:42.0	+31:55:00	40.2 Mpc	···	···	···		
502	UGCA 319/320	P	Galaxy association	13:02:43.0	-17:19:10	5.4 Mpc	···	···	···		
503	Stephan's Quintet	P	Galaxy association	22:35:57.5	+33:57:36	···	···	···	$3.2' \times 3.2'$		
504	NGC 6482	P	Galaxy association	17:51:48.8	+23:04:19	59.0 Mpc	···	···	$1.5' \times 57.7''$		
505	Fornax Cluster	P	Galaxy association	3:38:30.0	-35:27:18	···	···	···	···		
506	Virgo Cluster	P	Galaxy association	12:26:32.1	+12:43:24	···	···	···	···		
507	Coma Cluster	P	Galaxy association	12:59:48.7	+27:58:50	···	···	···	···		
508	Perseus Cluster	P	Galaxy association	3:19:47.2	+41:30:47	···	···	···	···		
509	Bullet Cluster	PS	Galaxy association	6:58:29.6	-55:56:39	···	···	···	···		
510	SSA22	P	Galaxy association	22:17:34.7	+0:15:07	···	···	···	···		357
511	Abell 3667	P	Galaxy association	20:12:33.7	-56:50:26	···	···	···	···		
512	Coma C	P	Galaxy association	12:59:18.0	+27:47:00	···	···	···	···		
513	NGC 1275 minihalo	P	Galaxy association	3:19:48.2	+41:30:42	62.5 Mpc	···	···	$2.6' \times 1.8'$		
514	1253+275	P	Galaxy association	12:55:00.0	+27:12:00	···	···	···	···		
515	Leo Ring	P	LSS	10:47:46.8	+12:11:11	···	···	···	···		358
516	Laniakea (Great) attractor	P	LSS	14:32	-43:14	71.0 Mpc	···	···	···		359
517	Dipole repeller	P	LSS	22:25	+37:15	238.6 Mpc	···	···	···		360
536	Galactic anticenter	P	Not real	5:45:37.2	+28:56:10	···	···	···	···		
539	Cha 110913-773444	S	Minor body	11:09:13.6	-77:34:45	165.0 pc	···	···	···		361, 362
545	1SWASP J140752.03-394415.1 b	S	Minor body	14:07:52.0	-39:44:15	1.4 kpc	4.8	-0.7	···		363, 364
551	Kepler 138 b	S	Solid planetoid	19:21:31.6	+43:17:35	67.0 pc	-20.6	22.7	···		365, 366
552	Kepler 37 b	S	Solid planetoid	18:56:14.3	+44:31:05	64.0 pc	-60.5	48.7	···		367
553	Kepler 107 c	S	Solid planetoid	19:48:06.8	+48:12:31	534.0 pc	-9.5	0.3	···		368
554	82 Eri	S	Solid planetoid	3:19:55.7	-43:04:11	6.0 pc	3038.3	726.6	···	✓	369, 370
555	KOI 1843.03	S	Solid planetoid	19:00:03.1	+40:13:15	134.8 pc	0.7	41.2	···		371, 372
556	HAT-P-67 b	S	Giant planet	17:06:26.6	+44:46:37	375.7 pc	9.4	-18.2	···		373, 374
557	Kepler 51 c	S	Giant planet	19:45:55.1	+49:56:16	801.7 pc	0.0	-7.5	···		375
558	KELT 9 b	S	Giant planet	20:31:26.4	+39:56:20	205.7 pc	16.7	21.5	···		376, 377
559	TrES-2 b	S	Giant planet	19:07:14.0	+49:18:59	216.4 pc	5.2	1.6	···		378, 379

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
560	V830 Tau b	S	Giant planet	4:33:10.0	+24:33:43	130.6 pc	7.2	-21.2	···		380, 381
561	κ And b	S	Giant planet	23:40:24.5	+44:20:02	50.1 pc	80.7	-18.7	···		382, 383
562	o UMa b	S	Giant planet	8:30:15.9	+60:43:05	60.5 pc	-133.8	-107.5	···		384, 385
563	HD 208527 b	S	Giant planet	21:56:24.0	+21:14:23	314.5 pc	1.2	15.0	···		386
564	GJ 3483 B	S	Giant planet	8:07:14.7	-66:18:49	19.2 pc	340.3	-289.6	···		387
565	HD 163269 b	S	Giant planet	17:55:54.5	-12:52:13	257.1 pc	-3.4	-11.0	···		388, 389
566	R136 a1	S	Star	5:38:43.3	-69:06:08	49.6 kpc	···	···	···		390, 391, 392
567	EBLM J0555-57 Ab	S	Star	5:55:32.7	-57:17:26	211.6 pc	2.8	-39.6	···		393
568	Feige 34	S	Star	10:39:36.7	+43:06:09	227.3 pc	12.5	-25.4	···		394, 395
569	NML Cyg	S	Star	20:46:25.5	+40:06:59	653.6 pc	-0.3	-0.9	···		396, 397
570	UY Sct	S	Star	18:27:36.5	-12:27:59	1.6 kpc	-0.7	-3.0	···		398
571	SMSS J0313-6708	S	Star	3:13:00.4	-67:08:39	10.0 kpc	7.0	1.1	···		399
572	14 Her	S	Star	16:10:24.3	+43:49:03	17.9 pc	132.0	-296.5	···	✓	400
573	SDSS J102915+172927	S	Star	10:29:15.1	+17:29:28	1.4 kpc	-10.9	-4.1	···		401
574	S4711	S	Star	17:45:40.0	-29:00:28	8.2 kpc	···	···	···		402
575	S5-HVS1	S	Star	22:54:51.6	-51:11:44	8.6 kpc	35.3	0.6	···		403, 404
576	SDSS J222859.93+362359.6	S	Collapsed star	22:28:59.9	+36:23:60	286.0 pc	-2.9	-2.0	···		405
577	U Sco	S	Collapsed star	16:22:30.8	-17:52:43	12.6 kpc	0.5	-7.9	···		406
578	LHS 4033	S	Collapsed star	23:52:31.9	-2:53:12	30.2 pc	637.8	285.1	···		407
579	PSR J2222-0137 B	S	Collapsed star	22:22:06.0	-1:37:16	267.2 pc	···	···	···		408
580	RX J0439.8-6809	S	Collapsed star	4:39:49.6	-68:09:01	9.2 kpc	···	···	···		409, 410
581	PG 1031+234	S	Collapsed star	10:33:49.2	+23:09:16	64.1 pc	-51.3	-11.8	···		411
582	WD 0346+246	S	Collapsed star	3:46:46.5	+24:56:03	27.8 pc	520.9	-1157.5	···		412
583	LP 400-22	S	Collapsed star	22:36:30.0	+22:32:24	353.5 pc	202.9	50.6	···		
584	4U 1538-522	S	Collapsed star	15:42:23.4	-52:23:10	6.4 kpc	-6.7	-4.1	···		
585	MSP J0740+6620	S	Collapsed star	7:40:45.8	+66:20:34	2.0 kpc	···	···	···		413
586	PSR J0537-6910	S	Collapsed star	5:37:46.7	-69:10:17	49.6 kpc	···	···	···		414
587	PSR J2144-3933	S	Collapsed star	21:44:12.1	-39:33:55	160.0 pc	···	···	···		415
588	XTE J1739-285	S	Collapsed star	17:39:54.0	-28:29:47	12.0 kpc	···	···	···		
589	AX J1910.7+0917	S	Collapsed star	19:10:43.6	+9:16:30	16.0 kpc	···	···	···		416
590	IGR J00291+5934	S	Collapsed star	0:29:03.1	+59:34:19	5.1 kpc	···	···	···		
591	SGR 1900+14	S	Collapsed star	19:07:13.0	+9:19:34	13.5 kpc	···	···	···		
592	NS 1987A	S	Collapsed star	5:35:28.0	-69:16:11	49.6 kpc	···	···	···		417
593	PSR B1508+55	S	Collapsed star	15:09:25.7	+55:31:33	2.4 kpc	···	···	···		418
594	PSR J1748-2446ad	S	Collapsed star	17:48:04.9	-24:46:04	6.9 kpc	···	···	···		419
595	PSR J0250+5854	S	Collapsed star	2:50:17.8	+58:54:01	1.6 kpc	···	···	···		420
596	2MASS J05215658+4359220	S	Collapsed star	5:21:56.6	+43:59:22	3.7 kpc	-0.1	-3.7	···		
597	HM Cnc	S	Interacting binary star	8:06:23.0	+15:27:31	5.0 kpc	···	···	···		421
598	NGC 5907 ULX	S	Interacting binary star	15:15:58.6	+56:18:10	17.1 Mpc	···	···	···		422
599	TWA 42	S	Stellar group	11:19:32.5	-11:37:47	26.4 pc	-148.5	-98.1	···		423, 424
600	Melnick 34	S	Stellar group	5:38:44.3	-69:06:06	9.1 kpc	1.9	0.8	···		425
601	PSR J2322-2650	S	Stellar group	23:22:34.6	-26:50:58	227.3 pc	-2.4	-8.3	···		426
602	ZTF J153932.16+502738.8	S	Stellar group	15:39:32.2	+50:27:39	2.3 kpc	-3.4	-3.8	···		427, 428

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	D_L^{eff}	μ_α	μ_δ	Θ	I17?	Refs
603	65 UMa	S	Stellar group	11:55:05.7	+46:28:37	86.8 pc	22.7	-19.4	···		429
604	IRS 13E	SA	Stellar group	17:45:39.7	-29:00:30	8.2 kpc	···	···	···		430
605	NGC 7252 W3	S	Stellar group	22:20:43.9	-24:40:38	64.4 Mpc	···	···	$0.1'' \times 0.1''$		
606	HD 97950	S	Stellar group	11:15:07.3	-61:15:39	7.0 kpc	2.4	2.8	···		431
607	Be 17	S	Stellar group	5:20:37.4	+30:35:24	2.7 kpc	2.6	-0.3	···		
608	NGC 6791	S	Stellar group	19:20:53.0	+37:46:18	6.9 kpc	-0.4	-2.3	···		432
609	G1	S	Stellar group	0:32:46.5	+39:34:40	785.0 kpc	···	···	$1.7'' \times 1.7''$		433, 434
610	(GC) 037-B327	S	Stellar group	0:41:35.0	+41:14:55	785.0 kpc	···	···	···		435
611	M85-HCC 1	S	Stellar group	12:25:22.8	+18:10:54	15.8 Mpc	···	···	$0.0'' \times 0.0''$		436, 437
612	Kim 3	S	Stellar group	13:22:45.2	-30:36:04	15.1 kpc	···	···	···		438
613	NGC 6522	S	Stellar group	18:03:34.1	-30:02:02	7.7 kpc	2.6	-6.4	$2.1' \times 2.1'$		439, 440
614	ESO 280-SC06	S	Stellar group	18:09:06.0	-46:25:24	21.4 kpc	-0.5	-2.8	···		441
615	NGC 6528	S	Stellar group	18:04:49.6	-30:03:21	7.9 kpc	-2.2	-5.5	···		442, 443
616	Boomerang Nebula	S	ISM	12:44:46.1	-54:31:13	197.8 pc	-2.9	-1.6	$1.4' \times 43.4''$		
617	Sgr B2	S	ISM	17:47:20.4	-28:23:07	8.2 kpc	···	···	···		444
618	Sgr B2(N) AN01	S	ISM	17:47:19.9	-28:22:18	8.2 kpc	···	···	···		445
619	30 Dor	S	ISM	5:38:36.0	-69:05:11	49.6 kpc	···	···	$40.0' \times 25.0'$		446
620	W49N	S	ISM	19:10:13.2	+9:06:12	11.1 kpc	···	···	···		447
621	Segue 2	S	Galaxy	2:19:16.0	+20:10:31	35.0 kpc	···	···	···		
622	Segue 1	S	Galaxy	10:07:03.2	+16:04:25	23.0 kpc	···	···	···		
623	IC 1101	S	Galaxy, AGN	15:10:56.1	+5:44:41	···	···	···	$52.6'' \times 29.5''$		
624	OGC 21	S	Galaxy	12:22:05.3	+45:18:11	···	···	···	$19.0'' \times 11.0''$		
625	LEDA 088678	S	Galaxy	12:59:22.5	-4:11:46	···	···	···	$28.6'' \times 25.1''$		
626	M59-UCD3	S	Galaxy	12:42:11.0	+11:38:41	15.3 Mpc	···	···	···		448, 449
627	SPT 0346-52	S	Galaxy	3:46:41.2	-52:05:06	···	···	···	···		450, 451
628	WISE J101326.25+611220.1	S	Galaxy	10:13:26.2	+61:12:20	···	···	···	···		452
629	Antlia 2	S	Galaxy	9:35:32.8	-36:46:02	132.0 kpc	···	···	···		453
630	Reticulum II	S	Galaxy	3:35:42.1	-54:02:57	32.0 kpc	···	···	···		
631	GN-z11	S	Galaxy	12:36:25.5	+62:14:31	···	···	···	···		454, 455
632	MACS0647-JD	S	Galaxy	6:47:55.7	+70:14:36	···	···	···	···		456, 457
633	ZF-COSMOS-20115	S	Galaxy	10:00:14.8	+2:22:43	···	···	···	···		
634	AGC 229385	S	Galaxy	12:32:10.3	+20:25:24	10.9 Mpc	···	···	$1.6' \times 43.2''$		458, 459
635	J0811+4730	S	Galaxy	8:11:52.1	+47:30:26	···	···	···	···		460
636	NGC 2841	S	Galaxy	9:22:02.7	+50:58:35	14.6 Mpc	···	···	$8.1' \times 4.0'$		461
637	IRAS 14070+0525	S	Galaxy	14:09:30.7	+5:11:31	···	···	···	···		462
638	SS 14	S	Galaxy	9:57:27.0	+8:35:02	···	···	···	···		463, 464
639	SS 03	S	Galaxy	16:39:46.0	+46:09:06	···	···	···	$17.0'' \times 6.0''$		465, 466
640	A1689B11	S	Galaxy	13:11:33.3	-1:21:07	···	···	···	···		467
641	SPT-CLJ2344-4243 Arc	S	Galaxy	23:44:46.5	-42:43:06	···	···	···	···		468, 469
642	The Snake	S	Galaxy	12:06:10.8	-8:48:01	···	···	···	···		470, 471
643	RGG 118	S	AGN	15:23:03.8	+11:45:45	···	···	···	···		
644	Holm 15A	S	AGN	0:41:50.5	-9:18:11	201.4 Mpc	···	···	$38.0'' \times 29.6''$		
645	HS 1946+7658	S	AGN	19:44:54.9	+77:05:53	···	···	···	···		
646	SMSS 2157-36	S	AGN	21:57:28.2	-36:02:15	···	···	···	···		472

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
647	WISE 2246-0526	S	AGN	22:46:07.6	-5:26:35	···	···	···	···		
648	M60-UCD1	S	AGN	12:43:36.0	+11:32:05	16.2 Mpc	···	···	···		473
649	J1329+3234	S	AGN	13:29:32.4	+32:34:17	···	···	···	···		
650	J1342+0928	S	AGN	13:42:08.1	+9:28:38	···	···	···	···		
651	CLASH B1938+666	S	AGN	19:38:25.3	+66:48:53	···	···	···	···		474
652	COSMOS 5921+0638	S	AGN	9:59:21.7	+2:06:38	···	···	···	···		475
653	J1420-0545	S	AGN	14:20:23.8	-5:45:28	···	···	···	···		
654	J0804+3607	S	AGN	8:04:31.0	+36:07:18	···	···	···	···		
655	HCG 54	S	Galaxy association	11:29:15.0	+20:34:42	···	···	···	$42.0'' \times 42.0''$		
656	Seyfert's Sextet	S	Galaxy association	15:59:11.6	+20:45:25	···	···	···	$1.3' \times 1.3'$		
657	Abell 370	S	Galaxy association	2:39:50.5	-1:35:08	···	···	···	···		
658	MACS J0717.5+34	S	Galaxy association	7:17:36.5	+37:45:23	···	···	···	···		
659	Abell 665	S	Galaxy association	8:30:45.2	+65:52:55	···	···	···	···		
660	Phoenix Cluster	S	Galaxy association	23:44:40.9	-42:41:54	···	···	···	···		
661	CL J1001+0220	S	Galaxy association	10:00:57.2	+2:20:13	···	···	···	···		
662	A2744z8OD	S	Galaxy association	0:14:24.9	-30:22:56	···	···	···	···		
663	Shapley Supercluster	S	LSS	13:06:00.0	-33:04:00	···	···	···	···		
664	HE 0430-2457	A	Stellar group	4:33:03.8	-24:51:20	978.4 pc	3.0	0.8	···		476
665	PSR J1911-5958A	A	Stellar group	19:11:42.8	-59:58:27	4.0 kpc	···	···	···		477, 478
666	PSR J1740-5340	A	Star, Stellar group	17:40:44.6	-53:40:41	2.3 kpc	···	···	···		479
667	S0-2	A	Star	17:45:40.0	-29:00:28	8.2 kpc	-10.9	19.7	···		480, 481
668	IRS 16C	A	Star	17:45:40.1	-29:00:28	8.2 kpc	-9.0	7.8	···		482, 483
669	G2	A	ISM	17:45:40.0	-29:00:28	8.2 kpc	···	···	···		484
670	ASASSN -14jb	A	Collapsed star	22:23:16.1	-28:58:31	···	···	···	···		
671	SN 2009ip	A	Collapsed star	22:23:08.3	-28:56:52	···	···	···	···		
672	HVGC-1	A	Stellar group	12:30:54.7	+12:40:59	16.5 Mpc	···	···	···		485, 486
673	3C 186	A	AGN	7:44:17.5	+37:53:17	···	···	···	···		
674	SDSS J113323.97+550415.9	A	AGN	11:33:24.0	+55:04:16	···	···	···	···		
677	HIP 41378 f	A	Giant planet	8:26:27.8	+10:04:49	106.6 pc	-48.1	0.1	···		
678	HD 65949	A	Star	7:57:47.7	-60:36:35	440.2 pc	-4.2	10.9	···		
679	Przybylski's Star	A	Star	11:37:37.0	-46:42:35	108.8 pc	-46.8	34.0	···		487
680	HD 106038	A	Star	12:12:01.4	+13:15:41	134.8 pc	-218.5	-439.6	···		488
681	HD 135485	A	Star	15:15:45.3	-14:41:35	231.9 pc	-0.3	-35.0	···		489
682	LS IV-14 116	A	Star	20:57:38.9	-14:25:44	420.3 pc	7.5	-128.0	···		490, 491
683	2MASS J13535604+4437076	A	Star	13:53:56.1	+44:37:08	1.5 kpc	-44.4	-31.1	···		492
684	COM 6266B	A	Interacting binary star	17:01:12.7	-30:06:49	6.8 kpc	···	···	···		493
685	M67-S1063	A	Star	8:51:13.4	+11:51:40	847.7 pc	-11.0	-2.8	···		494, 495
686	[SBD2011] 5	A	Star	11:15:07.0	-61:15:26	7.0 kpc	···	···	···		496, 497
687	1E 1613-5055	A	Collapsed star	16:17:33.0	-51:02:00	3.2 kpc	···	···	···		

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
688	DWD HS 2220+2146	A	Stellar group	22:23:01.6	+22:01:30	70.6 pc	···	···	···		498
689	NGC 1277*	A	AGN	3:19:51.5	+41:34:24	67.7 Mpc	···	···	···		
690	Was 49b	A	AGN	12:14:17.8	+29:31:43	···	···	···	···		
691	2MASX J07390433+1804252	A	AGN	7:39:04.3	+18:04:25	···	···	···	23.0″ × 18.8″		
692	J 06587-5558	A	Unknown	6:58:42.1	-55:58:37	···	···	···	···		499
693	ASASSN -15lh	A	Unknown	22:02:15.4	-61:39:35	···	···	···	···		
694	CMB Cold Spot	A	LSS	3:13:00.0	-20:30:00	···	···	···	···		
696	Boyajian's Star	A	Minor body, Star	20:06:15.5	+44:27:25	450.8 pc	-10.4	-10.3	···	+	500
697	HD 139139	A	Minor body	15:37:06.2	-19:08:33	107.6 pc	-67.6	-92.5	···	+	501
698	VVV-WIT-07	A	Minor body	17:26:29.4	-35:40:56	···	···	···	···		
699	ASASSN-V J060000.76-310027.83	A	Star	6:00:00.8	-31:00:28	156.8 pc	-14.0	-17.0	···		502
700	WISEA 0615-1247	A	Star	6:15:43.6	-12:47:22	38.6 pc	450.3	-415.9	···		
701	45 Dra	A	Star	18:32:34.5	+57:02:44	1.1 kpc	0.4	-7.7	···		503
702	OGLE LMC-CEP-4506	A	Star	5:53:29.4	-67:53:59	50.0 kpc	1.6	0.7	···		504
703	EK Dra	A	Star	14:39:00.2	+64:17:30	34.5 pc	-136.0	-36.9	···		505
704	ASASSN-V J190917.06+182837.36	A	Star	19:09:17.1	+18:28:37	1.4 kpc	-0.7	-4.9	···		506
705	ASASSN-V J213939.3-702817.4	A	Star	21:39:39.3	-70:28:17	1.2 kpc	13.7	-13.1	···		507
706	ASASSN V J193622.23+115244.1	A	Star	19:36:22.2	+11:52:44	2.0 kpc	···	···	···		
707	NGC 3021-CANDIDATE 1	A	Star	9:50:55.4	+33:33:14	27.3 Mpc	···	···	···		508
708	BW Vul	A	Star	20:54:22.4	+28:31:19	870.0 pc	0.4	-5.0	···		509
709	BD +31°1048	A	Star	5:40:35.9	+31:21:30	247.9 pc	-5.1	-8.2	···		510
710	AQ CVn	A	Star	12:43:41.7	+32:21:28	3.0 kpc	-5.4	-3.6	···		511
711	β Cam	A	Star	5:03:25.1	+60:26:32	210.5 pc	-6.5	-14.2	···		512
712	V654 Her	A	Star	16:57:41.0	+35:16:11	427.3 pc	16.4	0.1	···		513
713	PTF 14jg	A	Star	2:40:30.1	+60:52:46	1.9 kpc	···	···	···		514
714	ASASSN-19lb	A	Star	11:39:49.4	-70:40:31	1.7 kpc	···	···	···		515, 516
715	ASASSN-20lj	A	Star	16:46:14.7	+17:00:18	862.1 pc	9.5	-11.1	···		517, 518
716	YZ CMi	A	Star	7:44:40.2	+3:33:09	6.0 pc	-348.1	-445.9	···	✓	519
717	Landstreet's Star	A	Star	5:40:56.4	-1:30:26	437.5 pc	2.8	1.7	···		520
718	GRB 060614	A	Collapsed star	21:23:32.1	-53:01:36	···	···	···	···		
719	GRB 060505	A	Collapsed star	22:07:03.4	-27:48:52	···	···	···	···		
720	PSR B0919+06	A	Collapsed star	9:22:14.0	+6:38:23	1.2 kpc	···	···	···		521
721	DDE 168	A	Star	13:05:14.6	-49:18:59	125.0 pc	-30.2	-16.4	···		
722	UMi dSph	A	Galaxy	15:09:11.3	+67:12:52	60.0 kpc	···	···	32.2′ × 32.2′	✓	522
723	NGC 247	A	Galaxy	0:47:08.6	-20:45:37	3.7 Mpc	···	···	20.4′ × 5.1′		523
724	Leoncino Dwarf	A	Galaxy	9:43:32.4	+33:26:58	8.0 Mpc	···	···	8.1″		524, 525
725	Spikey	A	AGN	19:18:45.6	+49:37:56	···	···	···	···		
726	ZTF19abanrhr	A	AGN	12:49:42.3	+34:49:29	···	···	···	···		
727	GSN 069	A	AGN	1:19:08.7	-34:11:31	···	···	···	15.4″ × 12.6″		
728	MCG+00-09-070	A	AGN	3:22:08.7	+0:50:11	···	···	···	27.2″ × 24.5″		
729	3C 141	A	Unknown	5:26:42.6	+32:49:58	···	···	···	···		
730	3C 125	A	Unknown	4:46:17.8	+39:45:03	···	···	···	···		
731	3C 431	A	Unknown	21:18:52.5	+49:36:59	···	···	···	···		
732	PMN J1751-2524	A	Unknown	17:51:51.3	-25:24:00	···	···	···	···		

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
733	FRB 121102	A	Unknown	5:32:09.6	+33:05:13	0.2 pc	···	···	···	+	526
734	ORC 2	A	Unknown	20:58:42.8	-57:36:57	···	···	···	80″		527
735	Galactic Center Radio Arc	A	Unknown	17:46:16.9	-28:48:52	8.2 kpc	1.9	-3.0	···		528
736	3FGL J1539.2-3324	A	Unknown	15:39:11.6	-33:22:06	···	···	···	···		
737	3FGL J1231.6-5113	A	Unknown	12:31:36.5	-51:13:16	···	···	···	···		
738	TeV J2032+4130	A	Unknown	20:32:06.0	+41:34:00	···	···	···	···		
739	HESS J1745-303	A	Unknown	17:45:11.3	-30:11:56	···	···	···	···		
740	LWAT 171018	A	Unknown	3:04	+2:00	···	···	···	···		529
741	ILT J225347+862146	A	Unknown	22:53:47.1	+86:21:46	···	···	···	···		
742	TGSSADR J183304.4-384046	A	Unknown	18:33:04.5	-38:40:46	···	···	···	49.5″ × 25.4″		
743	J103916.2+585124	A	Unknown	10:39:16.2	+58:51:24	···	···	···	···		
744	WJN J1443+3439	A	Unknown	14:43:22.0	+34:39:00	···	···	···	···		
745	43.78+59.3	A	Unknown	9:55:52.5	+69:40:45	···	···	···	···		
746	FIRST J141918.9+394036	A	Unknown	14:19:18.9	+39:40:36	···	···	···	···		
747	RT 19920826	A	Unknown	21:36:22.0	+41:59:20	···	···	···	···		
748	GCRT J1745-3009	A	Unknown	17:45:05.0	-30:09:54	···	···	···	···		
749	FRB 190523	A	Unknown	13:48:15.6	+72:28:11	···	···	···	···		
750	FRB 180916.J0158+65	A	Unknown	1:58:00.8	+65:43:00	···	···	···	···		
751	VVV-WIT-02	A	Unknown	17:53:02.1	-24:51:59	···	···	···	···		
752	OTS 1809+31	A	Unknown	18:11:00.0	+31:24:00	···	···	···	···		
753	MASTER OT J051515.25+223945.7	A	Unknown	5:15:15.2	+22:39:46	···	···	···	···		
754	USNO-B1.0 1084-0241525	AE	Unknown	14:57:36.6	+18:25:02	···	···	···	···		
755	PTF 11agg	A	Unknown	8:22:17.2	+21:37:38	···	···	···	···		
756	SN 2008S	A	Unknown	20:34:45.3	+60:05:58	7.7 Mpc	···	···	···		530
757	PTF 09dav	A	Unknown	22:46:55.1	+21:37:34	···	···	···	···		531
758	AT 2018cow	A	Unknown	16:16:00.3	+22:16:05	···	···	···	···		532
759	Dougie	A	Unknown	12:08:47.9	+43:01:21	···	···	···	···		533
760	XRT 000519	A	Unknown	12:25:31.6	+13:03:59	···	···	···	···		534
761	CDF-S XT1	A	Unknown	3:32:38.8	-27:51:34	···	···	···	···		
762	CXOU J124839.0-054750	A	Unknown	12:48:39.0	-5:47:50	···	···	···	···		535
763	M86 tULX-1	A	Unknown	12:26:02.3	+12:59:51	···	···	···	···		536
764	Swift J195509.6+261406	A	Unknown	19:55:09.6	+26:14:07	···	···	···	···		
765	IceCube neutrino multiplet	A	Unknown	1:42:48.0	+39:36:00	···	···	···	···		537
766	KIC 2856960	A	Stellar group	19:29:31.5	+38:04:36	800.4 pc	-10.6	-10.4	···		
767	AAE-061228	A	Unknown	18:48:34.0	+20:19:50	···	···	···	···		538
768	AAE-141220	A	Unknown	3:23:08.0	+38:39:18	···	···	···	···		539
769	AAC-150108	A	Unknown	11:25:48.0	+16:18:00	···	···	···	···		540
770	IRAS 16406-1406	E	Star	16:43:27.3	-14:12:00	···	···	···	···		
771	IRAS 20331+4024	E	Star	20:34:55.7	+40:35:06	···	···	···	···		
772	IRAS 20369+5131	E	Star	20:38:26.0	+51:41:41	···	···	···	···		
773	IRAS 04287+6444	E	Stellar group	4:33:28.0	+64:50:53	···	···	···	···		
774	UW CMi	E	Star	7:45:16.1	+1:10:56	961.5 pc	-3.0	-2.0	···		
775	WISE J224436.12+372533.6	E	Galaxy	22:44:36.1	+37:25:34	···	···	···	···		
776	UGC 3097	E	Galaxy	4:35:48.5	+2:15:30	···	···	···	28.0″ × 17.3″		541
777	NGC 814	E	Galaxy	2:10:37.6	-15:46:25	21.0 Mpc	···	···	42.4″ × 17.0″		
778	ESO 400-28	E	Galaxy	20:28:25.3	-33:04:29	···	···	···	40.0″ × 35.2″		

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs
779	MCG+02-60-017	E	Galaxy	23:47:09.2	+15:35:48	···	···	···	$35.6'' \times 17.1''$		
780	TYC 6111-1162-1	E	Star	12:50:54.4	-16:52:05	174.0 pc	-76.0	-7.8	···		542
781	UGC 5394	E	Galaxy	10:01:47.9	+36:29:55	39.6 Mpc	···	···	$1.1' \times 16.8''$		
782	NGC 4502	E	Galaxy	12:32:03.4	+16:41:16	33.7 Mpc	···	···	$36.4'' \times 21.1''$		543
783	NGC 4698	E	Galaxy	12:48:22.9	+8:29:15	25.5 Mpc	···	···	$3.1' \times 2.1'$		544
784	IC 3877	E	Galaxy	12:54:48.7	+19:10:42	27.9 Mpc	···	···	$41.8'' \times 12.5''$		
785	AGC 470027	E	Galaxy	7:03:26.8	-48:59:43	281.8 Mpc	···	···	$18.2'' \times 7.6''$		
786	HR 6171	E	Star	16:36:21.4	-2:19:29	9.9 pc	456.4	-309.3	···	✓	
787	GJ 1019	E	Star	0:43:35.6	+28:26:41	20.9 pc	-127.1	-1064.1	···		545
788	GJ 299	E	Star	8:11:57.6	+8:46:23	6.9 pc	1078.9	-5096.2	···		546
789	HD 220077	E	Star	23:20:52.9	+16:42:39	77.7 pc	33.7	-76.2	···		547
790	HIP 107359	E	Star	21:44:41.9	-16:31:37	170.3 pc	-59.2	-31.6	···		548
791	TYC 3010-1024-1	E	Star	11:04:19.8	+40:10:42	164.6 pc	-55.2	-10.7	···		
792	Wow! Signal (A)	E	Unknown	19:25:28.0	-26:56:50	···	···	···	···		549
793	Wow! Signal (B)	E	Unknown	19:28:17.0	-26:56:50	···	···	···	···		550
794	5.13h +2.1	E	Unknown	5:07:48.0	+2:06	···	···	···	···		551
795	08.00h -08.50	E	Unknown	8:01	-8:32	···	···	···	···		552
796	03.10h +58.0	E	Unknown	3:07	+58:02	···	···	···	···		553
797	11.03.91	E	Unknown	16:39:16.0	+30:31:04	···	···	···	···		554
798	WISE 0735-5946	E	Unknown	7:35:04.8	-59:46:12	···	···	···	···		
799	IRAS 16329+8252	E	Unknown	16:27:22.5	+82:45:46	···	···	···	···		
800	CSL-1	C	Galaxy association	12:23:30.5	-12:38:57	···	···	···	···		555
801	GRB 090709A	C	Collapsed star	19:19:46.7	+60:43:41	···	···	···	···		
802	GW100916 (A)	C	Not real	7:23:55.0	-27:31:48	···	···	···	···		556
803	GW100916 (B)	C	Not real	7:19:26.0	-27:34:12	···	···	···	···		557
804	HD 117043	C	Star	13:25:59.9	+63:15:41	20.9 pc	-392.5	220.9	···	✓	
805	Hertzsprung's Object	C	Not real	4:11:43.0	+59:53:57	···	···	···	···	✓	
806	HIP 114176	C	Not real	4:11:43.0	+59:53:57	···	···	···	···		
807	KIC 5520878	C	Star	19:10:23.6	+40:46:05	4.5 kpc	-5.2	-3.4	···		
808	KIC 9832227	C	Stellar group	19:29:16.0	+46:37:20	595.1 pc	-9.8	-5.8	···		
809	KOI 6705.01	C	Star	18:56:57.6	+41:49:09	85.8 pc	-148.9	-128.0	···		558
810	Perseus Flasher	C	Not real	3:13:39.0	+32:14:37	···	···	···	···		
811	PSR B1829-10 b	C	Collapsed star	18:32:40.9	-10:21:33	4.7 kpc	···	···	···		
812	OT 060420	C	Not real	13:40	-11:40	···	···	···	···		559
813	SSSPM J1549-3544	C	Star	15:48:40.2	-35:44:26	95.9 pc	-597.8	-535.9	···		560
814	Swift Trigger 954840	C	Not real	10:54:30.0	-49:34:52	···	···	···	···		561
815	TU Leo	C	Star	9:29:50.6	+21:22:52	841.9 pc	-23.2	-13.5	···		
816	VLA J172059.9+385226.6	C	Not real	17:20:59.9	+38:52:26	···	···	···	···		

Table E2 *continued*

Table E2 *(continued)*

ID	Name	Samples	Phyla	RA	Dec	$D_L^{\rm eff}$	μ_α	μ_δ	Θ	I17?	Refs

Note—**Samples** – All samples a target is in. P: Prototype, S: Superlative, A: non-SETI Anomaly, E: SETI Anomaly, C: Control.
$D_L^{\rm eff}$ – effective luminosity distance of target, after taking into account lensing magnification.
μ_α**,** μ_δ – Proper motion in RA and declination, respectively, in milliarcseconds per year.
Θ – Angular size of the target.
I17? – ✓: source is part of I17 sample; +: source is not part of I17 sample but has been observed in Breakthrough Listen campaign.
Refs – see full online appendices (http://seti.berkeley.edu/exotica/ or doi:10.5281/zenodo.4726253).

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(2009); (239) Harris (2010); (241) Harris (2010); (243) Harris (2010); (244) McConnachie et al. (2005); (246) Harris (2010); (247) Gravity Collaboration et al. (2019b); (249) Harris (2010); (250) Gregorio-Hetem et al. (2009); (251) McConnachie et al. (2005); (252) Blanco et al. (1975); Fassett & Graham (2000); Tully et al. (2015); (253) Liszt et al. (2009); (254) Benisty et al. (2013); (255) Großschedl et al. (2018); (256) Carey et al. (1998); Lin et al. (2017); (257) Pratap et al. (1997); Torres et al. (2009); (258) de Geus et al. (1989); (259) Kim et al. (2008); (260) van Dyk et al. (1998); (261) Hachisuka et al. (2006); (262) Fukui et al. (2014); (265) Raga et al. (2011); (266) Chen et al. (2010); Hung et al. (2019); (267) Shull & Danforth (2019); (268) Verbiest et al. (2012); (269) Ranasinghe & Leahy (2018); (270) Pietrzyński et al. (2019); (271) Granot et al. (2017); (272) Huang et al. (2012); (273) Faherty et al. (2007); Abeysekara et al. (2017); (274) Pietrzyński et al. (2019); (275) Sell et al. (2015); (276) Pietrzyński et al. (2019); (277) Marshall et al. (2013); (278) Ackermann et al. (2011); (279) Braun & Burton (1999); (285) McConnachie et al. (2005); (288) McConnachie et al. (2005); (291) Newman et al. (2018); (292) Newman et al. (2018); (302) Beaton et al. (2019); (306) Ogle et al. (2016); (315) Dunham et al. (2019); (317) Yuan et al. (2011); (319) Girard et al. (2018); (321) Marques-Chaves et al. (2018); (323) Dalcanton et al. (2009); (331) Vanzella et al. (2016); (333) Berg et al. (2018); (335) Seitz et al. (1998); Baker et al. (2004); (337) Swinbank et al. (2011); (341) Mei et al. (2007); Beasley et al. (2016); (343) Anand et al. (2018b); (354) Tully et al. (2015); (355) Venturini & Solomon (2003); (356) Keel et al. (2012); (357) Steidel et al. (1998); (358) Thilker et al. (2009); (359) Hoffman et al. (2017); (360) Hoffman et al. (2017); (362) Luhman et al. (2005); (392) Pietrzyński et al. (2019); (397) Zhang et al. (2012b); (404) Koposov et al. (2020); (406) Hachisu & Kato (2018); (408) Deller et al. (2013); (410) Werner & Rauch (2015); (413) Cromartie et al. (2020); (414) Pietrzyński et al. (2019); (415) Verbiest et al. (2012); (416) Rodes-Roca et al. (2013); (417) Pietrzyński et al. (2019); (418) Chatterjee et al. (2005); (419) Harris (2010); (420) Tan et al. (2018); (421) Roelofs et al. (2010); (422) Tully et al. (2013); (424) Best et al. (2017); (426) Spiewak et al. (2018); (428) Burdge et al. (2019); (430) Gravity Collaboration et al. (2019b); (431) Fukui et al. (2014); (434) McConnachie et al. (2005); (435) McConnachie et al. (2005); (437) Tully et al. (2013); (438) Kim et al. (2016); (440) Harris (2010); (441) Harris (2010); (443) Harris (2010); (444) Gravity Collaboration et al. (2019b); (445) Gravity Collaboration et al. (2019b); (446) Pietrzyński et al. (2019); (447) Zhang et al. (2013); (449) Tully et al. (2013); (451) Ma et al. (2016); (453) Torrealba et al. (2019); (455) Oesch et al. (2016); (457) Lam et al. (2019); (459) Anand et al. (2018b); (462) Baan et al. (1992); (464) Ogle et al. (2016); (466) Ogle et al. (2016); (469) Bayliss et al. (2020); (471) Ebeling et al. (2009); (472) Wolf et al. (2018); (473) Lee & Jang (2017); (474) Barvainis & Ivison (2002); (475) Anguita et al. (2009); (478) Harris (2010); (479) Harris (2010); (481) Gravity Collaboration et al. (2019b); (483) Gravity Collaboration et al. (2019b); (484) Gravity Collaboration et al. (2019b); (486) Caldwell et al. (2014); (493) Harris (2010); (497) Fukui et al. (2014); (499) Motta et al. (2018); (508) Jang & Lee (2017); (514) Hillenbrand et al. (2019); (516) Jayasinghe et al. (2019b); (518) Denisenko (2020); (521) Manchester et al. (2005); (525) Filho & Sánchez Almeida (2018); (526) Tendulkar et al. (2017); (527) Norris et al. (2021); (528) Gravity Collaboration et al. (2019b); (529) Varghese et al. (2019); (530) Anand et al. (2018a); (531) Sullivan et al. (2011); (532) Prentice et al. (2018); (533) Vinkó et al. (2015); (534) Tully et al. (2013); (535) Tully et al. (2013); (536) Tully et al. (2013); (537) Icecube Collaboration et al. (2017); (538) Gorham et al. (2018); (539) Gorham et al. (2018); (540) Aartsen et al. (2020); (549) Gray & Marvel (2001); (550) Gray & Marvel (2001); (551) Bowyer et al. (2016); (552) Horowitz & Sagan (1993); (553) Horowitz & Sagan (1993); (554) Colomb et al. (1995); (555) Agol et al. (2006); Sazhin et al. (2006); (556) Evans et al. (2012); (557) Evans et al. (2012); (559) Shamir & Nemiroff (2006); (561) Gropp et al. (2020)

Table E3. Relationships of sidereal *Exotica Catalog* targets

Object	ID	Relationship	Partner	Partner IDs
		Within Exotica catalog		
NGC 7293 central star	77	IN	Helix Nebula	365
Proxima b	84	BOUND	α Cen AB	321
Luhman 16B	137	IN	Luhman 16	323
		MUTUAL_ORBIT	Luhman 16B	137
Luhman 16A	138	IN	Luhman 16	323
		MUTUAL_ORBIT	Luhman 16A	138
61 Cyg B	146	MUTUAL_ORBIT	61 Cyg A	147
61 Cyg A	147	MUTUAL_ORBIT	61 Cyg B	146
HD 44179	178	IN	Red Rectangle nebula	364
Capella Ab	181	MUTUAL_ORBIT	Capella Aa	186
Capella Aa	186	MUTUAL_ORBIT	Capella Ab	181
ι Ori AB	192	IN	Orion A	351

Table E3 *continued*

Table E3 *(continued)*

Object	ID	Relationship	Partner	Partner IDs
		ADJACENT	M42	357
EZ CMa	198	IN	S 308	371
η Car	203	IN	Homunculus Nebula	370
M67-S1237	231	IN	M67	335
		ADJACENT	M67-S1063	685
ζ Oph	240	IN	ζ Oph cloud, ζ Oph bow shock	349, 363
Geminga	265	IN	Geminga halo	379
Crab pulsar	266	IN	Crab Nebula	376
Cygnus X-1	273	IN	Cygnus X-1 shell	384
NGC 6946-BH1	275	ADJACENT	SN 2008S	756
R Aqr	281	IN	R Aqr nebula	380
GK Per	287	IN	GK Per shell	381
SS433	309	IN	W50	386
M82 X-1	310	IN	M82	428
		ADJACENT	43.78+59.3, M82 X-2	745, 312
M101 ULX-1	311	IN	M101	414
M82 X-2	312	IN	M82	428
		ADJACENT	43.78+59.3, M82 X-1	745, 310
RZ 2109 ULX	313	IN	Virgo Cluster	506
PSR B1957+20	319	IN	PSR B1957+20 bow shock	378
α Cen AB	321	BOUND	Proxima b	084
Luhman 16	323	GROUP_OF	Luhman 16A, Luhman 16B	138, 137
M67	335	CONTAINS	M67-S1063, M67-S1237	685, 231
NGC 6752	340	CONTAINS	PSR J1911-5958A	665
M31-EC4	341	ADJACENT	(GC) 037-B327, M32, G1, NGC 205	610, 396, 609, 398
Central Cluster	343	CONTAINS	G2, IRS 13E, IRS 16C, S0-2, S4711, Sgr A*	669, 604, 668, 667, 574, 471
Cyg OB2	346	IN	Cygnus Cocoon	387
		ADJACENT	TeV J2032+4130	738
Cen A outer filament	348	IN	Centaurus A	479
ζ Oph cloud	349	CONTAINS	ζ Oph bow shock, ζ Oph	363, 240
Orion A	351	CONTAINS	ι Ori AB, M42, Orion hot core	192, 357, 355
Orion hot core	355	IN	Orion A, M42	351, 357
M42	357	IN	Orion A	351
		ADJACENT	ι Ori AB	192
		CONTAINS	Orion hot core	355
NGC 3603	359	CONTAINS	[SBD2011] 5, HD 97950	686, 606
ζ Oph bow shock	363	IN	ζ Oph bow shock	363
		CONTAINS	ζ Oph	240
Red Rectangle nebula	364	CONTAINS	HD 44179	178
Helix Nebula	365	CONTAINS	NGC 7293 central star	077
Homunculus Nebula	370	CONTAINS	η Car	203
S 308	371	CONTAINS	EZ CMa	198
SN 1987A	375	CONTAINS	NS 1987A	592
		ADJACENT	30 Dor, CAL 83 nebula, Melnick 34, N159F, OGLE LMC-CEP-4506, PSR J0537-6910, R136 a1	619, 382, 600, 385, 702, 586, 566
Crab Nebula	376	CONTAINS	Crab pulsar	266
PSR B1957+20 bow shock	378	CONTAINS	PSR B1957+20	319
Geminga halo	379	CONTAINS	Geminga	265
R Aqr nebula	380	CONTAINS	R Aqr	281
GK Per shell	381	CONTAINS	GK Per	287
CAL 83 nebula	382	ADJACENT	30 Dor, Melnick 34, N159F, NS 1987A, OGLE LMC-CEP-4506, PSR J0537-6910, R136 a1, SN 1987A	619, 600, 385, 592, 702, 586, 566, 375
Cygnus X-1 shell	384	CONTAINS	Cygnus X-1	273

Table E3 *continued*

Table E3 *(continued)*

Object	ID	Relationship	Partner	Partner IDs
N159F	385	ADJACENT	30 Dor, CAL 83 nebula, Melnick 34, NS 1987A, OGLE LMC-CEP-4506, R136 a1, SN 1987A	619, 382, 600, 592, 702, 566, 375
W50	386	CONTAINS	SS433	309
Cygnus Cocoon	387	CONTAINS	Cyg OB2, TeV J2032+4130	346, 738
SSA22a-LAB01	389	IN	SSA22	510
NGC 4636	391	IN	Virgo Cluster	506
M59	392	BOUND	M59-UCD3	626
		IN	Virgo Cluster	506
M32	396	ADJACENT	(GC) 037-B327, M31-EC4, G1, NGC 205	610, 341, 609, 398
NGC 205	398	ADJACENT	(GC) 037-B327, M31-EC4, M32, G1	610, 341, 396, 609
NGC 4431	401	IN	Virgo Cluster	506
NGC 1277	402	CONTAINS	NGC 1277*	689
		IN	Perseus Cluster	508
		ADJACENT	NGC 1265, NGC 1275 minihalo	481, 513
M101	414	CONTAINS	M101 ULX-1	311
M99	419	IN	Virgo Cluster	506
M82	428	CONTAINS	43.78+59.3, M82 X-1, M82 X-2	745, 310, 312
VCC 1287	441	IN	Virgo Cluster	506
HI 1232+20	443	CONTAINS	AGC 229385	634
M51a/b	447	CONTAINS	M51a	453
The Antennae	448	ADJACENT	Antennae TDG	449
Antennae TDG	449	ADJACENT	The Antennae	448
M51a	453	IN	M51a/b	447
M91	456	IN	Virgo Cluster	506
NGC 1365	461	IN	Fornax Cluster	505
UGC 7321	466	IN	Virgo Cluster	506
Sgr A*	471	IN	Central Cluster	343
		HOSTS	G2, IRS 13E, IRS 16C, S0-2, S4711	669, 604, 668, 667, 574
Centaurus A	479	CONTAINS	Cen A outer filament	348
NGC 1265	481	IN	Perseus Cluster	508
		ADJACENT	NGC 1275 minihalo, NGC 1277, NGC 1277*	513, 402, 689
Fornax Cluster	505	CONTAINS	NGC 1365	461
Virgo Cluster	506	CONTAINS	HVGC-1, M59, M59-UCD3, M85-HCC 1, M86 tULX-1, M91, M99, RZ 2109 ULX, UGC 7321, VCC 1287, XRT 000519	672, 392, 626, 611, 763, 456, 419, 313, 466, 441, 760
Coma Cluster	507	CONTAINS	Coma C, 1253+275	512, 514
Perseus Cluster	508	CONTAINS	NGC 1265, NGC 1275 minihalo, NGC 1277, NGC 1277*	481, 513, 402, 689
Bullet Cluster	509	LENSES	J 06587-5558	692
SSA22	510	CONTAINS	SSA22a-LAB01	389
Coma C	512	IN	Coma Cluster	507
		ADJACENT	1253+275	514
NGC 1275 minihalo	513	IN	Perseus Cluster	508
1253+275	514	IN	Coma Cluster	507
		ADJACENT	Coma C	512
R136 a1	566	IN	30 Dor	619
		ADJACENT	CAL 83 nebula, Melnick 34, N159F, NS 1987A, OGLE LMC-CEP-4506, PSR J0537-6910, SN 1987A	382, 600, 385, 592, 702, 586, 375
S4711	574	IN	Central Cluster	343
		ORBITS	Sgr A*	471
		ADJACENT	G2, IRS 13E, IRS 16C, S0-2	669, 604, 668, 667
PSR J0537-6910	586	ADJACENT	30 Dor, CAL 83 nebula, Melnick 34, N159F, NS 1987A, OGLE LMC-CEP-4506, R136 a1, SN 1987A	619, 382, 600, 385, 592, 702, 566, 375
NS 1987A	592	IN	SN 1987A	375

Table E3 *continued*

Table E3 *(continued)*

Object	ID	Relationship	Partner	Partner IDs
		ADJACENT	30 Dor, CAL 83 nebula, Melnick 34, N159F, OGLE LMC-CEP-4506, PSR J0537-6910, R136 a1	619, 382, 600, 385, 702, 586, 566
Melnick 34	600	IN	30 Dor	619
		ADJACENT	CAL 83 nebula, N159F, NS 1987A, OGLE LMC-CEP-4506, PSR J0537-6910, R136 a1, SN 1987A	382, 385, 592, 702, 586, 566, 375
IRS 13E	604	IN	Central Cluster	343
		ORBITS	Sgr A⋆	471
		ADJACENT	G2, IRS 16C, S0-2, S4711	669, 668, 667, 574
HD 97950	606	IN	NGC 3603	359
		ADJACENT	[SBD2011] 5	686
G1	609	ADJACENT	(GC) 037-B327, M31-EC4, M32, NGC 205	610, 341, 396, 398
(GC) 037-B327	610	ADJACENT	M31-EC4, M32, G1, NGC 205	341, 396, 609, 398
M85-HCC 1	611	IN	Virgo Cluster	506
Sgr B2	617	CONTAINS	Sgr B2(N) AN01	618
Sgr B2(N) AN01	618	IN	Sgr B2	617
30 Dor	619	CONTAINS	Melnick 34, R136 a1	600, 566
		ADJACENT	CAL 83 nebula, NS 1987A, OGLE LMC-CEP-4506, PSR J0537-6910, SN 1987A	382, 592, 702, 586, 375
M59-UCD3	626	BOUND	M59	392
		IN	Virgo Cluster	506
AGC 229385	634	IN	HI 1232+20	443
SPT-CLJ2344-4243 Arc	641	LENSED_BY	Phoenix Cluster	660
M60-UCD1	648	IN	Virgo Cluster	506
Phoenix Cluster	660	LENSES	SPT-CLJ2344-4243 Arc	641
PSR J1911-5958A	665	IN	NGC 6752	340
S0-2	667	IN	Central Cluster	343
		ORBITS	Sgr A⋆	471
		ADJACENT	G2, IRS 13E, IRS 16C, S4711	669, 604, 668, 574
IRS 16C	668	IN	Central Cluster	343
		ORBITS	Sgr A⋆	471
		ADJACENT	G2, IRS 13E, S0-2, S4711	669, 604, 667, 574
G2	669	IN	Central Cluster	343
		ORBITS	Sgr A⋆	471
		ADJACENT	IRS 13E, IRS 16C, S0-2, S4711	604, 668, 667, 574
HVGC-1	672	IN	Virgo Cluster	506
M67-S1063	685	IN	M67	335
		ADJACENT	M67-S1237	231
[SBD2011] 5	686	IN	NGC 3603	359
		ADJACENT	HD 97950	606
NGC 1277⋆	689	IN	NGC 1277, Perseus Cluster	402, 508
		ADJACENT	NGC 1265	481
J 06587-5558	692	LENSED_BY	Bullet Cluster	509
OGLE LMC-CEP-4506	702	ADJACENT	30 Dor, CAL 83 nebula, Melnick 34, N159F, NS 1987A, PSR J0537-6910, R136 a1, SN 1987A	619, 382, 600, 385, 592, 586, 566, 375
TeV J2032+4130	738	IN	Cygnus Cocoon	387
		ADJACENT	Cyg OB2	346
43.78+59.3	745	IN	M82	428
		ADJACENT	M82 X-1, M82 X-2	310, 312
SN 2008S	756	ADJACENT	NGC 6946-BH1	275
XRT 000519	760	IN	Virgo Cluster	506
		ADJACENT	M86 tULX-1	763
M86 tULX-1	763	IN	Virgo Cluster	506
		ADJACENT	XRT 000519	760
NGC 4502	782	IN	Virgo Cluster	506
NGC 4698	783	IN	Virgo Cluster	506

Table E3 *continued*

Table E3 *(continued)*

Object	ID	Relationship	Partner	Partner IDs
Wow! Signal (A)	792	ALTERNATE_POSITION	Wow! Signal (B)	793
Wow! Signal (B)	793	ALTERNATE_POSITION	Wow! Signal (A)	792
GW100916 (A)	802	ALTERNATE_POSITION	GW100916 (B)	803
GW100916 (B)	803	ALTERNATE_POSITION	GW100916 (A)	802
With I17 targets				
ϵ Ind Bb	136	BOUND	GJ845A	···
MSX SMC 055	191	IN	SMC	···
UV Cet	225	MUTUAL_ORBIT	GJ 65A	···
Sirius B	246	MUTUAL_ORBIT	Sirius A	···
NGC 6946-BH1	275	IN	NGC 6946	···
RZ 2109 ULX	313	IN	M49	···
YY Gem	329	BOUND	Castor AB	···
M31-EC4	341	BOUND	M31	···
NGC 604	347	IN	M33	···
Sextans A hole	356	IN	Sextans A	···
SN 1987A	375	IN	LMC	···
CAL 83 nebula	382	IN	LMC	···
N159F	385	IN	LMC	···
M32	396	BOUND	M31	···
NGC 205	398	BOUND	M31	···
M51a/b	447	CONTAINS	NGC 5195	···
M51a	453	ADJACENT	NGC 5195	···
Virgo Cluster	506	CONTAINS	NGC 4489, NGC 4486B, M87, M49, NGC 4478, M86, NGC 4473, NGC 4660, M60, M87, M84, NGC 4564, NGC 4551, NGC 4387, NGC 4239, NGC 4458	···
R136 a1	566	IN	LMC	···
PSR J0537-6910	586	IN	LMC	···
NS 1987A	592	IN	LMC	···
Melnick 34	600	IN	LMC	···
G1	609	BOUND	M31	···
(GC) 037-B327	610	BOUND	M31	···
30 Dor	619	IN	LMC	···
M60-UCD1	648	BOUND	M60	···
OGLE LMC-CEP-4506	702	IN	LMC	···
SN 2008S	756	IN	NGC 6946	···
XRT 000519	760	IN	M86	···
M86 tULX-1	763	IN	M86	···

Note—**Relationships** – ADJACENT: object's sky location is projected within same parent object as partner.
ALTERNATE_POSITION: additional possible sky location for source if poorly localized.
BOUND: gravitationally bound with, orbital motion of either partner too slow to detect or period > 10,000 yr.
CONTAINS: partner's sky location is projected within boundaries of object.
GROUP_OF: object consists entirely of collection of listed objects.
HOSTS: partner orbits object, object's reflex motion too small to detect.
IN: object's sky location is within bounds of other object.
LENSES: object is gravitational lens of partner, implying the partner appears projected within the object.
LENSED_BY: object is gravitationally lensed by partner, implying the object appears projected within its partner.
MUTUAL_ORBIT: object and partner bound, both with detectable orbital motion.
ORBITS: object orbits partner, partner's reflex motion too small to detect.

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