Original Research Article

A Multi-Criteria Framework for Rogue Planet Target Selection and Propulsion Feasibility Assessment: The Case for SIMP J0136+0933

Harshavardan Rajesh Gayathri

Pine Crest School, 1501 NE 62nd St, Fort Lauderdale, FL 33334, United States

ABSTRACT

Rogue planets are planetary-mass objects that are not gravitationally bound to a star. Their low brightness makes them difficult to detect, but their atmospheres can be observed without the severe star–planet contrast produced by a luminous host star. They can also provide benchmarks for the cooling and evolutionary models used to infer the properties of directly imaged exoplanets, particularly when their ages are independently constrained. No reproducible framework was identified in the literature reviewed that compares rogue planets as possible spacecraft destinations. This study therefore identifies the highest-ranked target for a first-generation robotic flyby and tests whether published propulsion cases could return encounter data within a human-relevant timeframe of 50 to 100 years. Six exact-phrase searches of the NASA Astrophysics Data System returned 428 records, from which 23 systems within 100 light-years met the screening conditions. A multi-criteria decision analysis scored each system from 1 to 5 on four criteria covering physical characterization, formation and early-evolution diagnostic value, navigation readiness, and distance burden. Scientific value and mission feasibility received equal weight. SIMP J0136+0933 ranked highest with a relative decision score of 4.25 and ranked first or tied for first in four of five reported scenarios. The leading target changed only when scientific value received 70% of the total weight. Returning encounter data from its distance of 19.92 light-years within 100 years requires a cruise velocity of 0.2488c. Rocket-equation mass-ratio checks ruled out practical use of chemical, nuclear-thermal, and ion propulsion for this requirement. Only a conceptual directed-energy lightsail with a projected velocity of 0.26c nominally satisfied the 100-year calculation, returning data after an estimated 96.5 years. Its payload, power, communication, and post-encounter operating requirements remain unresolved; nominal timing compliance therefore does not establish mission feasibility.

Keywords: rogue planets; free-floating planets; SIMP J0136+0933; interstellar travel; multi-criteria decision analysis; propulsion systems; target selection; exoplanet exploration

INTRODUCTION

A rogue planet is a planetary-mass object that travels through the galaxy without being gravitationally bound to any star (1). Related unbound planetary-mass objects appear in the literature under several other names, including free-floating planet, free-floating planetary-mass object, isolated planetary-mass object, and interstellar planet. Their usage is not fully standardized, and they are not always interchangeable (2).

Corresponding author: Harshavardan Rajesh Gayathri, E-mail: harsharajeshg@gmail.com.

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Classifying these objects is not straightforward, because two different systems are in use and they do not always agree. The first is based on mass. The International Astronomical Union's Working Group on Extrasolar Planets set the boundary at the minimum mass needed to fuse deuterium, approximately 13 Jupiter masses at solar metallicity. Under this mass-based convention, objects below the deuterium-burning limit that orbit a star are classified as planets, whereas substellar objects above the limit are classified as brown dwarfs regardless of how they formed (3). That limit is not exact and has been calculated to fall anywhere between approximately 11.0 and 16.3 Jupiter masses depending on metallicity, helium abundance, and initial deuterium abundance (4). Because the definition requires a planet to orbit a star, a free-floating object below the limit is strictly neither a planet nor a brown dwarf. The Working Group proposed the term sub-brown dwarf for this case, although it is rarely used in practice (2, 3).

The second system is based on formation history. Under this system, a brown dwarf is an object that formed like a star, through the collapse of a molecular cloud, while a planet formed within a circumstellar disk through processes such as core accretion or disk instability (5). The two systems can label the same object differently, because an object of a few Jupiter masses that formed by cloud collapse is planetary by mass but star-like by formation (2, 5). Since formation history cannot be observed directly and must be inferred, classification in practice relies mostly on mass (3). This reliance is disputed, and it has been argued that the mass limit has no physical justification because deuterium burning plays no role in how either brown dwarfs or giant planets form (5).

This study adopts the mass-based system because mass is the principal classification variable reported for the candidate objects and can be applied consistently across the candidate set. Within the literature-derived candidate set defined in the Methods, an unbound object is treated as a rogue planet if its reported mass or plausible mass range is compatible with the adopted deuterium-burning limit, and the term rogue planet is used throughout in that sense. The adopted boundary is uncertain (4). Objects with reported masses close to it are therefore retained but flagged as disputed.

Two formation pathways are generally proposed for rogue planets: independent formation through collapse of a molecular-cloud fragment, and formation within a planetary system followed by ejection (2, 6). Several ejection mechanisms may contribute (6, 7). They are detected primarily through gravitational microlensing or through observations of infrared emission from residual formation heat, which is strongest in younger objects (1, 8).

Rogue planets are scientifically valuable for two related reasons. First, their infrared emission can be observed without the severe star–planet contrast produced by a luminous host star, although their low intrinsic brightness remains an observational challenge (2, 8). Second, because they receive no sustained irradiation from a host star, their thermal emission provides evidence about how planetary-mass objects cool and evolve in relative isolation. Cooling models predict different luminosities for objects with different initial thermal states, and those models are also used to estimate the properties of directly imaged planets (9). Rogue planets with independently constrained ages can therefore serve as complementary benchmarks for testing models of substellar evolution.

Remote observations nevertheless leave important properties uncertain. Rogue planets generally appear as unresolved point sources, and properties such as radius, surface gravity, and mass are commonly inferred by combining spectra, luminosities, age estimates, atmospheric models, and evolutionary calculations rather than by direct measurement (9, 10). Different combinations of age, mass, atmospheric properties, and initial thermal state can sometimes reproduce similar observations. A close robotic encounter could provide resolved imaging and higher-quality spectroscopic and atmospheric measurements, improving constraints on these properties and on the models used to interpret them. This potential scientific return provides the motivation for evaluating rogue planets as possible spacecraft destinations.

Prioritization frameworks exist in related areas, but they address different problems. Analytic metrics have been developed to rank transiting exoplanets by the expected signal-to-noise of atmospheric measurements (11). These order targets by how well they can be observed from Earth, not by whether a spacecraft could reach them (11). Interstellar mission studies have examined trajectories and propulsion in detail, but they concentrate on optimizing the route to a small set of nearby stars rather than on ranking candidate destinations by scientific value (12, 13). The rogue-planet literature itself is concerned mainly with detection methods and population statistics (1, 2, 14). No framework was identified in the literature reviewed for this study that compares literature-reported rogue-planet candidates against both scientific value and mission feasibility using an explicit and reproducible scoring method.

For this comparison, scientific value means the extent to which close-range measurements could contribute to testing models of planetary formation, atmospheric properties, and early evolution. Mission feasibility means the practicality of locating, intercepting, and communicating with a target, considering its distance and the completeness of its astrometric and kinematic information. A first-generation robotic mission is defined as an uncrewed flyby carrying remote-sensing instruments, such as cameras and spectrometers, without depending on infrastructure established by an earlier interstellar mission. A human-relevant timeframe is defined as approximately 50 to 100 years from launch to the arrival of encounter data at Earth. An operationally relevant window additionally requires the spacecraft to remain functional after encounter for at least one Earth–spacecraft round-trip light time. A maximum round-trip light time of 200 years, corresponding to a target distance of 100 light-years (ly), is adopted as the candidate-screening boundary; whether a target within that boundary can return encounter data within 50 to 100 years is evaluated separately in the propulsion analysis.

Propulsion technologies are grouped into three author-defined tiers based on the NASA technology readiness level (TRL) scale (15). Demonstrated systems are at TRL 6 or above as of 2026, near-term systems are at TRL 4 or 5 with a plausible route to TRL 6 within approximately 25 years, and conceptual systems are below TRL 4. An integrated mission architecture is classified according to the maturity of the complete system rather than that of its individual components.

To address the identified gap, this study uses multi-criteria decision analysis (MCDA), an established method for comparing alternatives across multiple criteria (16). The study aims to identify the highest-ranked target for a first-generation robotic flyby within the literature-derived candidate set, assigning equal weight to scientific value and mission feasibility, and then to determine whether the published performance of demonstrated, near-term, or conceptual propulsion technologies could return encounter data from that target within the defined human-relevant timeframe.

METHODS AND MATERIALS

Study Design

This study used a two-stage design. The first stage identified and ranked literature-reported rogue-planet systems within a defined mission scope using a multi-criteria decision analysis (MCDA). The second stage evaluated published propulsion technology cases for the highest-ranked target. Target selection was performed without reference to the performance of any propulsion technology subsequently evaluated. The propulsion analysis subsequently used the identity and distance of the highest-ranked target as inputs. The final candidate ranking was calculated using the finalized screening rules, criteria, rubrics, weights, and sensitivity scenarios. All scoring was performed by the author.

Stage 1: Target-Selection Multi-Criteria Decision Analysis

Search and Screening

Candidates were assembled through a targeted search of the NASA Astrophysics Data System (ADS). Six exact-phrase searches were conducted, each followed by the number of records it returned: “rogue planet”, 39 records; “free-floating planet”, 293; “free-floating planetary-mass object”, 43; “isolated planetary-mass object”, 38; “sub-brown dwarf”, 7; and “planetary-mass member”, 8. All searches were run on 2 August 2026 in the abstract field, restricted to refereed publications from 1995 to 2026. Query strings took the form abs:”phrase” property:refereed year:1995-2026, giving 428 records in total before removal of records retrieved by more than one phrase.

Records retrieved by more than one phrase were counted once. Titles and ADS keywords were screened to remove theoretical studies, instrumentation and mission-concept papers, and papers unrelated to unbound planetary-mass objects. Retained papers were examined to identify individually named systems and to extract the candidate-specific information needed for eligibility assessment. Population-level reports were retained when they provided individually identifiable candidates and excluded when candidate-specific evidence was unavailable. Alternative names and repeated reports were consolidated using published coordinates and designations. Literature terminology defined the retrieval scope only. Objects were then evaluated using the mass-based operational definition adopted in the Introduction. Because nomenclature for these objects is not standardized, the resulting candidate set is literature-derived and search-bounded rather than a complete census.

A retrieved system entered the MCDA only if it met three conditions. First, scientific eligibility: the object is not known to be gravitationally bound to a star; it is individually identifiable in peer-reviewed literature, with a candidate-specific spectrum yielding a published classification or explicit spectroscopic evidence of youth and substellar nature; individual coordinates, an individually estimated mass or mass range, and a stated basis for any association-derived distance or age are available. The mass condition is set out below.

Second, targetability. Because this analysis selects a destination for a spacecraft rather than a subject for remote observation, a system was required to be a persistent, re-observable source with published coordinates and a distance or distance constraint, recoverable in future observations for further astrometric measurement. The condition requires recoverability, not a complete present-day interception solution; the precision of the available astrometry is scored separately under Criterion 3. Targetability is non-compensatory, so a system failing it was excluded rather than allowed to offset the failure elsewhere. Detection method was therefore treated as part of eligibility rather than as a scored criterion.

Third, mission scope. Systems were restricted to central published distance estimates not exceeding 100 light-years, corresponding to the 200-year round-trip communication window defined in the Introduction. Systems whose central estimate fell inside the boundary but whose uncertainty interval crossed it were retained and flagged; more distant systems remain in the screening record but were not scored. Systems passing all three conditions formed the MCDA set. The number of systems remaining at each stage is reported in the Results.

The reported mass was assessed using 13 M_J as the operational boundary adopted for this study. This boundary was used as a screening convention rather than as an exact physical distinction between planets and brown dwarfs. A system was retained when at least one current, candidate-specific published mass estimate or uncertainty interval extended below 13 M_J. Systems lacking a candidate-specific mass estimate were excluded, as were systems whose current published mass estimates lay entirely at or above the boundary.

Uncertainty at the mass boundary did not result in automatic exclusion. Systems were retained as disputed candidates when their published mass intervals crossed 13 M_J, when current sources reported conflicting estimates on opposite sides of the boundary, or when the mass estimate depended on uncertain age or moving-group membership. All systems passing the mass condition, whether securely below the boundary or disputed, entered the MCDA. A disputed classification carried no automatic numerical penalty; the underlying uncertainty was reflected in the evidence-supported minimum, central, and maximum scores for the criteria affected.

Scores were assigned only from candidate-specific, peer-reviewed evidence. Primary discovery and characterization studies were preferred for measured quantities; review articles were used only for classification and methodological context. A later study replaced an earlier one only where it clearly superseded it, as when a trigonometric parallax replaces a photometric distance. Where current studies disagreed beyond their stated uncertainties, both readings were retained as conflicting evidence. Quantities inferred from membership were labeled association-dependent and quantities inferred from evolutionary models were labeled model-derived. Missing evidence was recorded explicitly.

<u>Criteria and Scoring Rubrics</u>

The criterion set was developed using established guidance that decision attributes should be unambiguous, comprehensive, direct, operational, understandable, and non-redundant (17, 18). The decision objective was divided into scientific value and mission feasibility, with two criteria assigned to each category. The four criteria and their scoring boundaries are author-defined; the cited literature establishes why each dimension is relevant rather than prescribing this particular framework. Each criterion was scored on a five-point ordinal scale, with 1 representing the least preferred eligible condition and 5 the most preferred. The complete rubrics are given in Table 1. Alternative category weights and evidence-supported score ranges were examined through sensitivity analysis, while the criterion selection and scoring boundaries remain methodological limitations.

Criterion 1, Physical-Characterization Baseline and Interpretability, measures whether the existing physical description of a candidate is sufficiently secure for encounter observations to be interpreted against a documented baseline. Many substellar properties are inferred by combining candidate-specific observations with atmospheric or evolutionary models rather than through direct measurement (10). Model-derived values were therefore not downgraded solely because models were used; scoring instead considered the quality of the candidate-specific inputs, reported uncertainties, and support for the adopted age or membership.

Criterion 2, Formation and Early-Evolution Diagnostic Value, measures whether candidate-specific observations from a close encounter could help distinguish between competing explanations of formation or early evolution. Published research identifies observable consequences of different formation and initial thermal conditions (5, 9). Evidence was counted only when it was reported for the candidate and linked in peer-reviewed literature to a competing explanation. Young age, proximity to the deuterium-burning boundary, and uncertain membership did not count as diagnostics by themselves because none independently distinguishes between formation pathways.

Criterion 3, Navigation and Interception Readiness, measures the completeness of the astrometric and kinematic information needed to predict a candidate's future position. Navigation analyses show that ephemeris uncertainty affects flyby delivery accuracy and the need for autonomous optical navigation (19). Scoring therefore considered individual parallax, proper motion, radial velocity, their reported uncertainties, and relevant multiplicity information. Propagated encounter-position error was not calculated because doing so would require an assumed encounter date and cruise velocity, making target selection dependent on the subsequent propulsion analysis.

Criterion 4, Distance, Transit and Communication Burden, measures the mission consequences of distance. Transit duration increases with distance at any specified cruise velocity, while round-trip communication delay is 2d/c. The 100-light-year candidate-screening boundary therefore corresponds to a 200-year round-trip light time. The boundary and its division into five equal 20-light-year scoring bands are author-defined. No cruise velocity or absolute transit time was assumed during target selection.

Table 1. *Scoring rubrics for the four criteria.*

Score	Level description
	Criterion 1. Physical-Characterization Baseline and Interpretability
5	Multiple candidate-specific studies constrain the spectral energy distribution or spectrum, bolometric luminosity or effective temperature, surface gravity, and mass and age with reported uncertainties. At least one atmospheric property, such as composition or cloud structure, has also been analyzed, and the principal physical interpretation is supported by independent observations or analyses.
4	Candidate-specific spectroscopy and photometry constrain effective temperature or bolometric luminosity and surface gravity, and published mass and age estimates are accompanied by an object-specific age or membership basis and stated uncertainties. Atmospheric composition, cloud properties, or temporal behavior may remain incompletely characterized.
3	Spectroscopy establishes spectral type and is supported by multi-band photometry. Estimates of temperature, gravity, mass or age are available, but depend substantially on generic model assumptions, an unconfirmed association membership, or another assumption not independently supported by candidate-specific evidence.
2	A candidate-specific spectrum confirms the object's substellar nature and provides an approximate classification, but wavelength coverage or data quality is limited. Other physical parameters have broad ranges or rely mainly on an assumed age.
1	The candidate-specific spectrum satisfies the eligibility condition but supports little beyond classification. No well-constrained candidate-specific estimates of the principal physical parameters are available, or their interpretation depends entirely on an unconfirmed assumption.
	Criterion 2. Formation and Early-Evolution Diagnostic Value
5	The candidate presents at least two independent diagnostic axes, each supported by candidate-specific evidence and linked in the literature to competing formation or early-evolution explanations. Close-range measurements capable of distinguishing predictions are identified for both axes.
4	The candidate presents one strong diagnostic axis for which competing explanations and relevant close-range measurements are explicitly identified in the literature. Multiple observations may support the axis, but causally related observations are not counted independently.
3	A candidate-specific property has published relevance to formation or early evolution, but its interpretation remains indirect, strongly model-dependent, or insufficiently developed to yield clearly distinguishable encounter predictions.

Continued Table 1. *Scoring rubrics for the four criteria.*

Score	Level description
	Criterion 2. Formation and Early-Evolution Diagnostic Value
2	The candidate is relevant mainly through general properties shared with a broader population. No strong candidate-specific diagnostic axis has been established, although close-range measurements could contribute to population-level formation or evolutionary studies.
1	The reviewed literature identifies neither a candidate-specific diagnostic axis nor a formation or early-evolution hypothesis that measurements from a close encounter could presently distinguish.
	Criterion 3. Navigation and Interception Readiness
5	An individual trigonometric parallax, both proper-motion components, and a measured radial velocity are available with reported uncertainties. Known multiplicity has been resolved or its astrometric effect has been constrained, permitting propagation of a three-dimensional position and velocity.
4	An individual trigonometric parallax and both proper-motion components are available with reported uncertainties, but radial velocity is absent or multiplicity remains incompletely constrained. Accurate sky-plane propagation is possible, but the three-dimensional motion is incomplete.
3	Individual parallax and proper-motion measurements exist, but at least one is preliminary, conflicting, or dependent on unresolved multiplicity. Future position can be estimated, but significant refinement is required.
2	Individual proper motion is available, but distance is photometric, kinematic, or association-derived rather than measured through individual trigonometric parallax. Encounter prediction depends materially on assumed membership or model-dependent distance.
1	No reliable individual parallax and no complete individual proper-motion measurement are available. Position or motion is primarily inferred from association membership or other indirect evidence, so substantial new astrometric observations would be required before interception planning.
	Criterion 4. Distance, Transit and Communication Burden
5	$0 < d \leq 20$ ly, round-trip light time ≤ 40 years. Lowest burden.
4	$20 < d \leq 40$ ly, round-trip light time > 40 to 80 years. Low burden.
3	$40 < d \leq 60$ ly, round-trip light time > 80 to 120 years. Moderate burden.
2	$60 < d \leq 80$ ly, round-trip light time > 120 to 160 years. High burden.
1	$80 < d \leq 100$ ly, round-trip light time > 160 to 200 years. Highest burden within scope.

Weighting, Uncertainty and Validation

A weighted additive model was selected because it makes the contribution of each criterion and weight explicit (16). Scores were combined using the weighted-sum model $T_i = w_{SV}(s_{i1} + s_{i2})/2 + w_{MF}(s_{i3} + s_{i4})/2$, where s_{i1} and s_{i2} are the scores on the two scientific-value criteria, s_{i3} and s_{i4} are the scores on the two mission-feasibility criteria, and $w_{SV} + w_{MF} = 1$. Weight pairs are always reported in scientific-value and mission-feasibility order. Because criterion scores range from 1 to 5, T_i is reported on the same scale as a relative decision score rather than a percentage. The model assumes approximately equal changes in decision value between successive ordinal levels, which is treated as a limitation.

The equal-weight baseline assigns 0.50 to each category, or 0.25 to every criterion. This is a transparent author-selected value judgment rather than an empirical result (20). No formal expert elicitation was undertaken, so alternative weights and evidence-supported score ranges were examined through sensitivity analysis.

Each candidate received a central score on each criterion representing the best-supported interpretation of the admissible evidence. More recent evidence replaced earlier evidence only where it clearly superseded it; otherwise credible current studies were considered together. Where credible current evidence supported more than one rubric level, the lowest, central and highest supported levels were recorded. Central scores were used for the primary ranking, and the minimum and maximum supported scores were used to test whether evidence uncertainty altered the ordering. Uncertainty was propagated by interval analysis rather than random sampling, because no basis exists for assuming a probability distribution over rubric levels.

Ranking stability was examined across five reported scenarios. The central-score, equal-weight case served as the baseline. Two alternative weighting scenarios assigned 0.70 to scientific value and 0.30 to mission feasibility, and then 0.30 to scientific value and 0.70 to mission feasibility. Within each category, its two criteria retained equal weights. Two evidence scenarios recomputed the equal-weight ranking using the minimum and then the maximum evidence-supported score for every candidate.

The criteria were defined to reduce double-counting of the same decision consequence. Characterization security and the precision of mass and age estimates were represented together under Criterion 1 because both describe how securely an object is already known. Distance, transit burden, and communication delay were represented together under Criterion 4 because distance is their common driver. Detection method was applied as a targetability condition rather than as a scored criterion because it determines eligibility rather than degree. The retained criteria were therefore intended to represent four different decision consequences. Because a single author assigned all scores, no inter-rater agreement statistic can be reported.

The search specification permits the retrieval step to be repeated. Appendix A provides the system-level screening record and Appendix B the candidate-level evidence, scores, uncertainty ranges, and sources.

Stage 2: Propulsion Technology Evaluation

The second stage evaluated whether published propulsion cases could return encounter data from the highest-ranked target within 50 to 100 years. Chemical, nuclear-thermal, electric or ion, and directed-energy lightsail propulsion were considered. These categories represent demonstrated, near-term, and conceptual technologies but are not an exhaustive review of interstellar propulsion. Performance values were taken from technical publications, agency sources, and established propulsion references (12, 21, 22, 23, 24, 25, 26, 27). Technology maturity was recorded separately from performance evidence, so a projected velocity was not treated as a demonstrated capability.

For a target at distance d and cruise velocity v, transit time was calculated as

$$t_{transit} = d / v.$$

One-way light-travel time was added to determine when encounter data would reach Earth:

$$T = t_{transit} + d / c.$$

When velocity is expressed as a fraction of the speed of light, v = βc, and distance is expressed in light-years,

$$T = d / \beta + d.$$

For H > d, the minimum velocity required for a data-return limit H was calculated as

$$\beta_{required} = d / (H - d).$$

A value of β ≥ 1 was treated as physically inadmissible for a spacecraft. Calculations assumed constant cruise velocity and immediate transmission at encounter. Acceleration, deceleration, course corrections, detailed interception geometry, and increasing communication distance after flyby were not modeled, so the calculated times are optimistic.

Reaction-propulsion systems were checked using the Tsiolkovsky rocket equation,

$$\Delta v = I_{sp}\, g_0 \ln(m_0 / m_f), \quad m_0 / m_f = \exp(\Delta v / I_{sp}\, g_0),$$

where I_sp is specific impulse, g0 is 9.80665 m/s squared, and m0 / mf is the initial-to-final mass ratio. The velocity required by the 100-year limit was used as Δv. Deceleration and reserve velocity were excluded, and the classical equation understates the mass ratio at relativistic velocity; the resulting values were therefore treated as optimistic lower bounds. The equation was not applied to externally driven lightsails.

The required post-encounter operating life was calculated as one round-trip light time, 2d / c. Payload, power, communication, navigation, and post-encounter lifetime were recorded as unresolved when the cited sources did not demonstrate them. A propulsion case meeting the calculated travel-time limit was therefore not automatically considered a complete feasible mission.

RESULTS

Stage 1: Target Selection

The six searches returned 428 records. Removing records retrieved by more than one phrase left 369 unique papers. Screening on titles and ADS keywords excluded 278 of these as theoretical studies, instrumentation or mission-concept papers, or as unrelated to unbound planetary-mass objects. Of the 91 remaining papers, 66 were excluded because a screening condition could be determined from the record and established object information. The remaining 25 papers were examined individually; 2 were excluded on assessment, and 23 papers contributed candidate systems to the eligibility assessment.

Extraction from the retained papers produced 65 systems and populations, listed in Appendix A. Applying the three screening conditions gave a final MCDA set of 23 systems. Two were included without classification-related flags, WISE J0855-0714 and PSO J318.5-22, while 21 were retained as disputed or conditional candidates. All 23 entered the MCDA. The largest single contribution was a uniform analysis of young T dwarfs (28), which supplied 13 candidates whose planetary-mass estimates depend on moving-group membership. None had a measured radial velocity confirming that membership.

Table 2 gives the central score of every candidate on each criterion and the resulting relative decision score under equal weighting. Candidates with equal totals share a rank. Appendix B gives the evidence, the uncertainty range and the sources behind each score.

SIMP J0136+0933 ranked highest with a relative decision score of 4.25. PSO J318.5-22 and 2MASS J1324+6358 tied for second at 3.75. PSO J318.5-22 scored higher on both scientific criteria and is the only candidate scoring 5 on Criterion 1, while SIMP J0136+0933 scored 5 on both mission-feasibility criteria.

Three candidates reached level 5 on Criterion 3 because they had complete parallax and proper-motion measurements together with a measured, rather than predicted, radial velocity. Eighteen candidates scored 4. That concentration reflects the typical evidence state in the candidate set: a measured trigonometric parallax and two-component proper motion, but no measured radial velocity. Missing radial-velocity measurements are therefore the principal navigation-data gap. No candidate reached level 5 on Criterion 2 because no candidate in the reviewed set had two independent diagnostic axes supported by candidate-specific evidence.

Table 2. *Central scores and relative decision scores for the 23 candidates under equal weighting.*

Rank	Candidate	C1	C2	C3	C4	T
1	SIMP J0136+0933	4	3	5	5	4.25
2	PSO J318.5-22	5	4	5	1	3.75
2	2MASS J1324+6358	4	3	5	3	3.75
4	WISE J0855-0714	3	2	4	5	3.50
4	UGPS J0722-0540	3	2	4	5	3.50
4	WISEPC J2255-3118	3	4	4	3	3.50
4	WISE J2332-4325	3	4	4	3	3.50
4	ULAS J1302+1308	3	4	4	3	3.50
9	WISE 1541-2250	2	2	4	5	3.25
10	WISE J1828+2650	2	2	4	4	3.00
10	WISE 2056+1459	2	2	4	4	3.00
10	WISE J0316+4307	3	2	4	3	3.00
10	WISEPA J0819-0335	3	2	4	3	3.00
10	WISEPA J0627-1114	3	2	4	3	3.00
10	2MASSI J1553+1532	3	2	4	3	3.00
16	WISE J0241-3653	3	2	4	2	2.75
16	SDSS J1521+0131	3	2	4	2	2.75
16	PSO J004.6+56.8	3	2	4	2	2.75
19	2MASS J1119-1137AB	3	4	2	1	2.50
19	2MASS J0013-1143	3	2	4	1	2.50
19	WISE J1636-0743	3	2	4	1	2.50
19	SDSS J1250+3925	2	2	4	2	2.50
23	2MASS J0326-2102	3	2	2	1	2.00

Table 3. *Highest-ranked candidate under the baseline and sensitivity scenarios.*

Scenario	Highest-ranked candidate	Score
Baseline: SV/MF = 0.50/0.50	SIMP J0136+0933	4.25
Science-prioritized: SV/MF = 0.70/0.30	PSO J318.5-22	4.05
Feasibility-prioritized: SV/MF = 0.30/0.70	SIMP J0136+0933	4.55
Minimum evidence scores: SV/MF = 0.50/0.50	SIMP J0136+0933 and PSO J318.5-22, tied	3.75
Maximum evidence scores: SV/MF = 0.50/0.50	SIMP J0136+0933	4.50

SIMP J0136+0933 ranked first or tied for first in four of the five reported scenarios. PSO J318.5-22 ranked first only under the science-prioritized 0.70/0.30 weighting, where it led by 0.10 on the five-point scale. Letting w denote the scientific-value weight, their relative decision scores are T_PSO = 3 + 1.5w and T_SIMP = 5 - 1.5w. The scores are equal at w = 2/3; PSO J318.5-22 therefore ranks above SIMP J0136+0933 only when scientific value receives more than approximately 66.7 percent of the total weight. Under the minimum-evidence scenario, the two candidates tied at 3.75.

Stage 2: Propulsion Feasibility

SIMP J0136+0933 lies at 19.92 light-years (28). Its one-way light-travel time is 19.92 years. Returning encounter data within 100 years leaves 80.08 years for transit and requires a minimum cruise velocity of 0.2488c, or 74,574 km/s. The 50-year limit leaves 30.08 years for transit and requires 0.6622c.

Table 4 summarizes all propulsion technologies evaluated. No published mission-specific interstellar cruise velocity was identified for chemical, nuclear-thermal, or ion propulsion, so these were assessed using their published specific impulses and the rocket equation. The lightsail cases were assessed using their published projected cruise velocities.

Transit times were not calculated for chemical, nuclear-thermal, or ion propulsion because the cited sources do not establish a mission-specific interstellar cruise velocity, and specific impulse does not by itself determine spacecraft velocity. The velocity required by the 100-year limit was instead tested using the rocket equation. The calculations omit deceleration, reserve velocity, and relativistic corrections, so the mass ratios are optimistic lower bounds and are physically impractical for all three systems. Of the three conceptual lightsail cases, the 0.10c and 0.20c cases return encounter data after 219.1 and 119.5 years, respectively. Only the highest projected-velocity case, 0.26c, falls within the 100-year limit, returning data after approximately 96.5 years. None of the evaluated technologies satisfies the 50-year limit.

As velocity approaches the speed of light, total data-return time approaches twice the target distance in years. A 100-year data-return time therefore requires a target at less than 50 light-years, while a 50-year return requires a target at less than 25 light-years. SIMP J0136+0933 lies within both distance limits, although none of the evaluated cases supplies the 0.6622c required by the 50-year limit.

Table 4. *Propulsion technologies evaluated for a mission to SIMP J0136+0933.*

Technology	Evidence input and status	Derived feasibility check	Transit (years)	Data at Earth (years)	Within 100 years
Chemical propulsion	Demonstrated propulsion principle; I_sp = 450 s (21)	Required m0/mf ≈ 10^7339	Not applicable: no supported interstellar cruise velocity	No, mass-ratio check	
Nuclear-thermal propulsion	Near-term propulsion principle; I_sp = 1,000 s (24, 25)	Required m0/mf ≈ 10^3303	Not applicable: no supported interstellar cruise velocity	No, mass-ratio check	
Ion propulsion	Demonstrated propulsion principle; I_sp = 8,000 s (22, 23)	Required m0/mf ≈ 10^413	Not applicable: no supported interstellar cruise velocity	No, mass-ratio check	
Directed-energy lightsail, 0.10c	Conceptual integrated mission case; published modeled value (12, 26)	Published projected velocity	199.2	219.1	No
Directed-energy lightsail, 0.20c	Conceptual integrated mission case; stated design target (27)	Published projected velocity	99.6	119.5	No
Directed-energy lightsail, 0.26c	Conceptual integrated mission case; largest baseline case in the directed-energy roadmap (12)	Published projected velocity	76.6	96.5	Yes, nominally

DISCUSSION

The equal-weight analysis identified SIMP J0136+0933 as the highest-ranked target because it provided the strongest balance between scientific value and mission feasibility, not because it led on every criterion. PSO J318.5-22 had the higher scientific-value subtotal, including the only score of 5 for Physical-Characterization Baseline and Interpretability, but its distance of 80.2 light-years produced the lowest distance score. SIMP J0136+0933 combined a comparatively strong scientific baseline with complete measured kinematics and a distance of 19.92 light-years. The selection therefore illustrates the purpose of the MCDA framework: factors favoring different targets are represented explicitly rather than resolved through an undocumented preference.

The recommendation is conditional on how scientific value and mission feasibility are weighted. SIMP J0136+0933 ranked first or tied for first in four of the five reported scenarios, whereas PSO J318.5-22 became the leading target when scientific value received 70 percent of the weight. The crossover occurred when scientific value received two-thirds of the total weight, and the candidates tied under the minimum-evidence scenario. SIMP J0136+0933 should therefore be interpreted as the highest-ranked target under the equal-weight baseline, rather than as an objectively superior destination under every possible set of priorities.

This comparison differs from the transiting-exoplanet prioritization metric considered in the literature review, which ranks targets according to expected atmospheric-observation signals from Earth (11). The present framework additionally considers navigation information, distance, communication delay, and transit burden. Similarly, the interstellar mission studies reviewed here begin with predetermined stellar destinations and then examine propulsion or trajectory design (12, 13). The present analysis instead demonstrates that destination choice and propulsion feasibility are connected: the candidate with the strongest scientific subtotal is not necessarily a target from which encounter data can be returned within a human-relevant timeframe.

The propulsion results demonstrate that connection. Returning encounter data from SIMP J0136+0933 within 100 years requires a cruise velocity of 0.2488c, which chemical, nuclear-thermal and ion propulsion cannot supply with practical mass ratios. The conceptual lightsail cases bracket the requirement: the 0.20c case misses the 100-year limit while the 0.26c case returns data after approximately 96.5 years. PSO J318.5-22, at 80.2 light-years, has a limiting data-return time of about 160.4 years even as velocity approaches the speed of light, so its higher scientific score cannot compensate for the timing constraint imposed by its distance.

The 0.26c result represents nominal travel-time compliance rather than a complete feasible mission. The value is the highest projected velocity for a gram-scale wafer in the directed-energy roadmap and has not been demonstrated (12). The separate 0.20c concept is also a design target rather than an achieved spacecraft velocity (27). The required 0.2488c lies close to the upper projection, leaving little allowance for acceleration time, course corrections, or reduced performance. The principal Stage 2 finding is therefore not that a rogue-planet flyby is presently feasible, but that the selected target falls within the physical timing boundary and that only the highest projected conceptual lightsail case nominally satisfies the 100-year requirement.

Several limitations qualify these results. All scoring was performed by one author, and the sensitivity tests examine alternative weights and evidence readings without replacing independent validation. The criteria, level boundaries, and baseline weights are author-defined. The candidate set is literature-derived and search-bounded rather than a complete census, obtained through six exact-phrase searches of one database on one date, so relevant objects described using other terminology may have been missed. Two retained candidates have upper distance bounds beyond the 100-light-year scope and would fall outside it under a conservative reading. The propulsion analysis assumes constant cruise velocity and does not model acceleration, deceleration, target-motion corrections, or interception geometry, and no braking or deceleration strategy was evaluated for the target encounter.

Several requirements beyond propulsion remain unresolved and were not modeled. At the cruise velocities considered, impacts with interstellar dust and gas would deposit energy on the leading surface, and no shielding design was assessed. Radiation exposure during cruise, degradation of sail and structural materials, and the long-duration power source needed to operate instruments and a transmitter after arrival were likewise not evaluated. The high-speed flyby would provide a limited encounter-observation window, so target acquisition and instrument pointing would need to be autonomous; no navigation or pointing-accuracy budget was developed. Encounter data would require onboard storage and transmission across 19.92 light-years; no communications link budget was calculated, and the transmitter power, antenna aperture and data rate achievable at gram scale remain open. A mission whose data return spans about a century also raises questions of institutional continuity and governance beyond the scope of this analysis. These are unresolved requirements rather than solved problems, and they are why the 0.26c timing result is described as nominal.

The results identify measured radial velocities as an immediate observational priority. Eighteen candidates scored 4 on Navigation and Interception Readiness, with radial velocity the common missing measurement, while the planetary-mass estimates of 13 candidates depend on unconfirmed moving-group membership. Radial-velocity measurements would therefore improve both future-position estimates and membership-dependent mass classifications. Independent rescoring and expert elicitation should test the reproducibility of the framework and its weights, and the screening conditions and rubrics allow newly discovered candidates to be scored by the same procedure. For propulsion, an integrated study of the 0.26c case should address the unresolved requirements above before the nominal timing result is treated as a credible mission concept.

CONCLUSION

This study applied a reproducible multi-criteria decision analysis to 23 literature-reported rogue-planet candidates within 100 light-years, scoring each on two scientific and two mission-feasibility criteria. Under equal weighting, SIMP J0136+0933 ranked highest at 4.25, ahead of PSO J318.5-22 and 2MASS J1324+6358 at 3.75, and ranked first or tied for first in four of the five reported scenarios.

The propulsion assessment returned a conditional feasibility result. SIMP J0136+0933 lies close enough that the study's 50 to 100 year timeframe is physically possible, unlike PSO J318.5-22, whose light-travel time alone exceeds the shorter bound. Only the highest projected-velocity conceptual lightsail case, 0.26c, nominally met the 100-year data-arrival bound, at 96.5 years. No demonstrated or near-term case met the timeframe, and no evaluated case established all required payload, communication and post-encounter capabilities.

The principal contribution is methodological: the framework makes the trade between scientific value and mission burden explicit and shows why the candidate with the strongest scientific subtotal is not necessarily the most suitable destination for a time-limited robotic mission.

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CONFLICT OF INTEREST

The author declares no conflicts of interest related to this work.

AI DISCLOSURE STATEMENT

During manuscript preparation, the author used AI tools (Claude, Anthropic) for literature checking, citation formatting, language editing, and organization. The author reviewed, verified, and edited the content and takes full responsibility for the accuracy, originality, and integrity of the work.

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APPENDIX A. *SUPPLEMENTARY TABLE S1. SYSTEM-LEVEL SCREENING RECORD*

Every system considered during candidate extraction, with the screening decision and the condition that determined it. Group rows cover populations excluded together at a single condition, with the region distance or detection method cited as the reason. Decisions follow the retention rule stated in the Methods. Of the systems listed, 23 were retained for scoring: 2 without classification flags and 21 as disputed.

Object	Alias	Screening decision	Basis	Source
WISE J085510.83-071442.5	WISE J0855-0714	Included	Mass 3-10 M_J, entirely below the boundary. Parallax 2.20 (+0.24,-0.20) pc (7.2 ly). Coldest known brown dwarf at about 225-260 K.	(29)
PSO J318.5338-22.8603	2MASS J21140802-2251358	Included	Mass 8.3 +/- 0.5 M_J at 23 +/- 3 Myr. Parallax 24.6 +/- 1.4 pc (80.2 ly), a distance-band boundary case. L7 with low-gravity indicators; beta Pic membership confirmed by radial velocity.	(8, 30)
SIMP J013656.5+093347.3	-	Included - disputed	Mass 12.7 +/- 1.0 M_J (Gagne 2017) against 15.6 (+2.4,-2.1) M_J (Zhang 2021). Current sources conflict across the boundary. Parallax 6.11 +/- 0.03 pc (19.9 ly).	(28, 31)
WISEPA J182831.08+265037.8	WISE J1828+2650	Included - disputed	Mass 0.5-20 M_J across ages 0.1-10 Gyr; the interval crosses the boundary. Parallax 11.2 (+1.3,-1.0) pc (36.5 ly).	(32)
2MASS J13243553+6358281	-	Included - disputed	Mass 11-12 M_J (Gagne 2018) against 13.2 (+1.8,-1.3) M_J (Zhang 2021). Sources conflict across the boundary. Trigonometric parallax 12.7 +/- 1.5 pc (41.4 ly).	(28, 33)
2MASS J11193254-1137466AB	2MASS J1119-1137AB	Included - disputed	Mass 4.3-7.6 M_J, entirely below the boundary, but conditional on TW Hya membership. Kinematic distance 28.9 +/- 3.6 pc (94.3 ly); the interval crosses the 100 ly condition. No trigonometric parallax.	(34)
2MASS J0326-2102	-	Included - disputed	Mass 18.40 +/- 6.46 M_J; the lower bound of 11.94 falls below the boundary. L4 vl-g, high-likelihood AB Doradus member awaiting a radial velocity. Distance is a statistical prediction of 26.1 +/- 2.0 pc (85.1 ly), not a measurement.	(35, 36)
UGPS J072227.51-054031.2	UGPS 0722-05	Included - disputed	Mass 3-11 M_J on the primary source, entirely below the boundary, but the age is bounded only between 60 Myr and 1 Gyr. A second source gives 5-40 M_J. Parallax 4.12 +/- 0.04 pc (13.4 ly).	(37)
WISEPC J205628.90+145953.3	WISE 2056+1459	Included - disputed	Mass 20 M_J with a range of 12-30, crossing the boundary. Parallax 7.1 +/- 0.1 pc (23.2 ly).	(38)
WISEP J154151.65-225025.2	WISE 1541-2250	Included - disputed	Mass 12 +/- 2 M_J, interval 10-14, crossing the boundary. Earlier modeling gave 12-31 M_J. Parallax 5.98 +/- 0.08 pc (19.5 ly).	(39)
WISEPC J225540.74-311841.8	-	Included - disputed	Mass 2.3 +0.2 -0.1 M_J, 2.2-2.5 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 45.9 ly.	(28)
WISE J233226.49-432510.6	-	Included - disputed	Mass 3.8 +0.7 -0.4 M_J, 3.4-4.5 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 49.9 ly.	(28)
WISE J031624.35+430709.1	-	Included - disputed	Mass 4.8 +0.7 -0.7 M_J, 4.1-5.5 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 44.5 ly.	(28)

CONTINUED APPENDIX A. *SUPPLEMENTARY TABLE S1. SYSTEM-LEVEL SCREENING RECORD*

Object	Alias	Screening decision	Basis	Source
WISE J024124.73-365328.0	-	Included - disputed	Mass 5.1 +0.4 -0.4 M_J, 4.7-5.5 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 62.2 ly.	(28)
ULAS J130217.21+130851.2	-	Included - disputed	Mass 5.6 +0.9 -0.9 M_J, 4.7-6.5 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 50.2 ly.	(28)
WISEPA J081958.05-033529.0	-	Included - disputed	Mass 5.7 +0.5 -0.5 M_J, 5.2-6.2 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 45.3 ly.	(28)
2MASS J00132229-1143006	-	Included - disputed	Mass 8.1 +0.7 -0.7 M_J, 7.4-8.8 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 81.5 ly.	(28)
SDSS J152103.24+013142.7	-	Included - disputed	Mass 8.5 +0.9 -0.9 M_J, 7.6-9.4 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 75.9 ly.	(28)
WISEPA J062720.07-111428.8	-	Included - disputed	Mass 11.1 +0.9 -0.7 M_J, 10.4-12.0 M_J, interval entirely below the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 43.5 ly.	(28)
2MASSI J1553022+153236	-	Included - disputed	Mass 12.0 +1.3 -1.0 M_J, 11.0-13.3 M_J, interval crosses the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 43.4 ly.	(28)
PSO J004.6359+56.8370	-	Included - disputed	Mass 12.3 +1.4 -1.0 M_J, 11.3-13.7 M_J, interval crosses the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 69.4 ly.	(28)
WISE J163645.56-074325.1	-	Included - disputed	Mass 13.1 +2.2 -1.5 M_J, 11.6-15.3 M_J, interval crosses the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 98.8 ly.	(28)
SDSS J125011.65+392553.9	-	Included - disputed	Mass 20.6 +5.2 -8.0 M_J, 12.6-25.8 M_J, interval crosses the boundary. Planetary mass conditional on moving-group membership that is unconfirmed; radial velocities are still required. Trigonometric parallax gives 75.9 ly. BANYAN Sigma gives 0.0 percent membership against 78 percent from LACEwING.	(28)
WISEP J004701.06+680352.1	WISE J0047+6803	Excluded - mass	Published mass approximately 0.018 M_sun (about 19 M_J), with the reported interval at or above the adopted 13 M_J boundary. No verified candidate-specific estimate extending below the boundary was identified.	(40)

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CONTINUED APPENDIX A. *SUPPLEMENTARY TABLE S1. SYSTEM-LEVEL SCREENING RECORD*

Object	Alias	Screening decision	Basis	Source
2MASS J21392676+0220226	-	Excluded - mass	14.6 (+3.2,-1.6) M_J; interval 13.0-17.8 lies at or above the boundary.	(28)
2MASS J22443167+2043433	J2244+2043	Excluded - mass	19.0 (+1.4,-1.5) M_J; interval 17.5-20.4 entirely above.	(35)
PSO J052.2746+13.3754	-	Excluded - mass	29.6 (+4.3,-2.9) M_J; interval 26.7-33.9 entirely above.	(28)
PSO J049.1159+26.8409	-	Excluded - mass	40.6 (+8.5,-7.1) M_J; interval 33.5-49.1 entirely above.	(28)
PSO J069.7303+04.3834	-	Excluded - mass	50.0 (+7.7,-11.9) M_J; interval 38.1-57.7 entirely above.	(28)
2MASS J00452143+1634446	J0045+1634	Excluded - mass	22.71 +/- 7.95 M_J; interval 14.76-30.66 entirely above.	(35)
2MASS J22064498-4217208	J2206-4217	Excluded - mass	21.74 +/- 8.52 M_J; interval 13.22-30.26 at or above.	(35)
2MASS J03552337+1133437	J0355+1133	Excluded - mass	30.3 +/- 6.8 M_J; interval 23.5-37.1 entirely above.	(35)
2MASSW J2148+4003	J2148+4003	Excluded - mass	55.03 +/- 18.55 M_J; interval 36.5-73.6 entirely above.	(35)
2MASS J00332386-1521309	J0033-1521	Excluded - mass	Lithium upper limits indicate an older age and a mass greater than approximately 0.06 M_sun (about 63 M_J). Its near-infrared spectrum is also classified as field gravity. These findings supersede the earlier low-mass interpretation conditional on young-association membership.	(41)
WISEPA J031325.96+780744.2	WISE 0313+7807	Excluded - mass	32 (+6,-7) M_J; interval 25-38 entirely above. Age about 6 Gyr.	(39)
2MASS J04151954-0935066	2MASS J0415-0935	Excluded - mass	27 (+7,-5) M_J; interval 22-34 entirely above. Age 4-6 Gyr.	(42)
2MASS J04210718-6306022	J0421-6306	Excluded - insufficient evidence	No candidate-specific mass estimate published. Fainter than G = 21, so Gaia yields no five-parameter astrometric solution.	(36)
2MASS J01291221+3517580	J0129+3517	Excluded - insufficient evidence	No candidate-specific mass estimate published.	(36)
2MASS J06322402-5010349	J0632-5010	Excluded - insufficient evidence	No candidate-specific mass estimate published.	(36)
2MASS J06420559+4101599	J0642+4101	Excluded - insufficient evidence	No candidate-specific mass estimate published; absent from Filippazzo 2015 Table 9 and Faherty 2016 Table 14.	(36)
EROS-MP J0032-4405	J0032-4405	Excluded - insufficient evidence	Lithium gives only an upper limit below 50 M_J, with no lower bound. Two published parallaxes disagree by 78 percent. Membership unassigned without a radial velocity.	(36)

CONTINUED APPENDIX A. *SUPPLEMENTARY TABLE S1. SYSTEM-LEVEL SCREENING RECORD*

Object	Alias	Screening decision	Basis	Source
2MASS J01033203+1935361	J0103+1935	Excluded - insufficient evidence	Revised to L6 pec with no clear low-gravity signature; membership re-evaluated as ambiguous, removing the age anchor.	(43)
2MASS J16471580+5632057	J1647+5632	Excluded - insufficient evidence	Updated parallax gives 66 percent probability of being a field object, removing the age anchor.	(44)
2MASS J21011544+1756586AB	J2101+1756	Excluded - insufficient evidence	Integrated-light spectrum shows no strong indication of youth, so no planetary-mass basis exists.	(45)
2MASS J23512200+3010540	J2351+3010	Excluded - insufficient evidence	Revised from Argus candidate to field object, removing the age anchor. Also lies 935 arcsec from BD+29 5007 at a matching parallax, suggesting a bound pair.	(43)
CFBDSIR J214947.2-040308.9	-	Excluded - mission scope	Parallax 18.3 +/- 1.8 mas; 1-sigma range 49.8-60.6 pc, central 178 ly.	(46)
WISEA J114724.10-204021.3	2MASS J11472421-2040204	Excluded - mission scope	Trigonometric parallax 37.3 +/- 2.8 pc (121.6 ly). Two of three published estimates lie beyond 100 ly.	(44)
2MASS J11151597+1937266	-	Excluded - mission scope	Distance 37 +/- 6 pc (120.7 ly), beyond the 30.7 pc scope limit.	(47)
WISE J1049-5319AB	Luhman 16	Excluded - unbound status and mass	Bound binary; L7.5 primary with T0.5 secondary at 2.0 +/- 0.15 pc.	(48)
beta Pictoris d	-	Excluded - unbound status	Orbits beta Pictoris.	(49)
Gl 570 D	-	Excluded - unbound status	Wide companion to the Gl 570ABC system, confirmed by common proper motion.	(50)
G 196-3B	J1004+5022	Excluded - unbound status	Wide companion to the M dwarf G 196-3A.	(36)
2MASS J0122-2439	-	Excluded - unbound status	Composite M3.5 + L5 system; the L5 is a companion.	(36)
2MASS J0249-0557 c	-	Excluded - unbound status	Component of the bound triple system 2MASS J0249-0557ABc, separated by 1950 au.	(51)
2MASS J22362452+4751425 b	-	Excluded - unbound status	Planetary-mass companion.	(52)

CONTINUED APPENDIX A. *SUPPLEMENTARY TABLE S1. SYSTEM-LEVEL SCREENING RECORD*

Object	Alias	Screening decision	Basis	Source
Ophiuchus wide planetary-mass companion	-	Excluded - unbound status	Companion at 200 au to the brown dwarf CFHTWIR-Oph 98 A, confirmed by common proper motion.	(53)
Upper Scorpius and Ophiuchus members	group	Excluded - mission scope	Association at about 145 pc, well beyond the 30.7 pc scope limit.	(54)
Taurus and LDN 1495 members	group	Excluded - mission scope	Region at about 140 pc.	(55)
sigma Orionis members	group	Excluded - mission scope	Cluster at about 400 pc.	(56)
Orion Nebula Cluster members	group	Excluded - mission scope	Cluster at about 400 pc.	(57)
NGC 1333 and IC 348 members	group	Excluded - mission scope	NGC 1333 and IC 348 in Perseus, at about 300 pc.	(58)
Chamaeleon members	group	Excluded - mission scope	Region at about 190 pc.	(59)
Pleiades members	group	Excluded - mission scope	Cluster at about 136 pc.	(60)
Lower Centaurus-Crux members	group	Excluded - mission scope	Association members at 115-200 pc, beyond the 30.7 pc scope limit.	(61)
Named microlensing events	group	Excluded - targetability	Single non-repeating detections; the source cannot be recovered for future observation.	(1, 14)

APPENDIX B. *SUPPLEMENTARY TABLE S2. CANDIDATE-LEVEL EVIDENCE AND SCORING RECORD*

Central score for each candidate on each criterion, with the plausible range in brackets where the published evidence supports more than one rubric level. C1 is Physical-Characterization Baseline and Interpretability, C2 is Formation and Early-Evolution Diagnostic Value, C3 is Navigation and Interception Readiness and C4 is Distance, Transit and Communication Burden. Level definitions are given in the Methods. Sources are the principal studies supporting the scores.

Candidate	C1	C2	C3	C4	Main sources	Evidence summary
WISE J0855-0714	3	2	4	5	(29, 62)	C1 field-age mass 3-10 M_J, no membership anchor. C2 no initial-entropy test available. C3 parallax and proper motions, no measured radial velocity. C4 7.2 ly.
PSO J318.5-22	5	4	5	1 (1, 2)	(8, 30, 63)	C1 membership confirmed by radial velocity, age and mass with uncertainties, cloud structure studied. C2 benchmark for hot-start against cold-start formation. C3 all three kinematic quantities measured. C4 80.2 ly.
SIMP J0136+0933	4 (4, 5)	3 (2, 3)	5	5 (4, 5)	(28, 31, 64)	C1 precise parallax and membership, two masses disagree across the boundary. C2 variability reported as weather, excluded as a diagnostic. C3 all three kinematic quantities measured. C4 19.92 ly, far bound crosses the 20 ly edge.
WISE J1828+2650	2 (2, 3)	2	4	4 (3, 4)	(32, 65)	C1 mass 0.5-20 M_J, no model fits the energy distribution. C2 an atmospheric-model problem, not a formation axis. C3 no measured radial velocity, multiplicity constrained. C4 36.5 ly, interval crosses 40 ly.
2MASS J1324+6358	4 (3, 4)	3	5	3 (3, 4)	(28, 33)	C1 measured radial velocity and 99.8 percent membership; two masses disagree. C2 L/T transition relevance is indirect. C3 all three kinematic quantities measured. C4 41.29 ly, interval crosses 40 ly.
2MASS J1119-1137AB	3 (2, 3)	4	2	1	(34)	C1 mass conditional on TW Hya membership. C2 resolved low-mass binary tests formation pathway. C3 kinematic distance only, no parallax. C4 94.3 ly, upper bound beyond scope.
2MASS J0326-2102	3 (2, 3)	2	2	1 (1, 2)	(35, 36)	C1 luminosity parameters rest on a predicted distance. C2 no candidate-specific axis. C3 no parallax and no radial velocity. C4 85.1 ly.
UGPS J0722-0540	3	2	4	5	(37)	C1 Teff 505 +/- 10 K but age spans 60 Myr to 1 Gyr. C2 field-age, population-level relevance. C3 precise parallax, no radial velocity. C4 13.4 ly.
WISE 2056+1459	2 (2, 3)	2	4	4	(38, 66)	C1 two analyses of differing completeness. C2 field Y dwarf. C3 parallax and proper motions, no radial velocity. C4 23.2 ly.
WISE 1541-2250	2 (2, 3)	2	4 (3, 4)	5	(39)	C1 successive analyses give different masses. C2 field Y dwarf. C3 published parallaxes conflict. C4 19.5 ly.
WISEPC J2255-3118	3 (2, 3)	4 (3, 4)	4	3	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 named in (28) as one of three objects testable against both hot-start and cold-start models. C3 parallax and proper motions, radial velocity predicted. C4 45.94 ly.

CONTINUED APPENDIX B. *SUPPLEMENTARY TABLE S2. CANDIDATE-LEVEL EVIDENCE AND SCORING RECORD*

Candidate	C1	C2	C3	C4	Main sources	Evidence summary
WISE J2332-4325	3 (2, 3)	4 (3, 4)	4	3	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 named in (28) as one of three objects testable against both hot-start and cold-start models. C3 parallax and proper motions, radial velocity predicted. C4 49.95 ly.
WISE J0316+4307	3 (2, 3)	2	4	3	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 44.50 ly.
WISE J0241-3653	3 (2, 3)	2	4	2 (2, 3)	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 62.24 ly, interval crosses 60 ly.
ULAS J1302+1308	3 (2, 3)	4 (3, 4)	4	3	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 named in (28) as one of three objects testable against both hot-start and cold-start models. C3 parallax and proper motions, radial velocity predicted. C4 50.18 ly.
WISEPA J0819-0335	3 (2, 3)	2	4	3	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 45.30 ly. Flagged in (28) as a weak composite candidate on one or two of six spectral-binary criteria; possible unresolved multiplicity is recorded but no astrometric bias is assumed.
2MASS J0013-1143	3 (2, 3)	2	4	1 (1, 2)	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 81.54 ly, interval crosses 80 ly. Flagged in (28) as a weak composite candidate on one or two of six spectral-binary criteria; possible unresolved multiplicity is recorded but no astrometric bias is assumed.
SDSS J1521+0131	3 (2, 3)	2	4	2 (1, 2)	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 75.85 ly, interval crosses 80 ly. Flagged in (28) as a weak composite candidate on one or two of six spectral-binary criteria; possible unresolved multiplicity is recorded but no astrometric bias is assumed.
WISEPA J0627-1114	3 (2, 3)	2	4	3	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 43.49 ly.

CONTINUED APPENDIX B. *SUPPLEMENTARY TABLE S2. CANDIDATE-LEVEL EVIDENCE AND SCORING RECORD*

Candidate	C1	C2	C3	C4	Main sources	Evidence summary
2MASSI J1553+1532	3 (2, 3)	2	4	3	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 43.43 ly.
PSO J004.6+56.8	3 (2, 3)	2	4	2	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 69.39 ly.
WISE J1636-0743	3 (2, 3)	2	4	1	(28)	C1 forward modeling gives all parameters with uncertainties but membership is unconfirmed. C2 population-level relevance only. C3 parallax and proper motions, radial velocity predicted. C4 98.84 ly, upper bound beyond scope. Flagged in (28) as a weak composite candidate on one or two of six spectral-binary criteria; possible unresolved multiplicity is recorded but no astrometric bias is assumed.
SDSS J1250+3925	2 (1–3)	2	4	2 (1, 2)	(28)	C1 membership contested between two algorithms. C2 no age anchor, so no entropy test. C3 parallax and proper motions, radial velocity predicted. C4 75.85 ly, interval crosses 80 ly.