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Searching the WISE preliminary catalog for massive planets in the Oort Cloud

John J. Matese and Daniel P. Whitmire
Department of Physics, University of Louisiana, Lafayette, Louisiana, USA
(matese@louisiana.edu / Fax: + 1-337-4826699)

Abstract

We discuss the evidence that a binary companion to our sun, more massive than Jupiter, may exist in the Oort comet cloud. WISE data is likely to ultimately verify or falsify the conjecture. A search procedure is presented and applied to the 57% of the sky covered in the 14 April 2011 preliminary release of the data by NASA.

1. Introduction

Recent simulations suggest that the Oort comet cloud may have been predominantly formed by capture of planetesimal ejecta from other stars in the dense birth cluster complex [10], [5]. In addition, very wide binary stars may form during the star cluster dissolution phase [4]. A recent microlensing study concluded that free floating Jovian mass objects, presumably ejected from young planetary systems, were more common than stars in the Galaxy [9]. We have considered the implications that a giant planet could also have been captured in the Sun's youth. In previous papers [6], [7], it has been noted that a persistent anomalous distribution of aphelia locations of observed outer Oort cloud comets suggests the possible existence of such an object orbiting in the inner regions of the outer Oort cloud. Equally interesting is the demonstration that such a solar companion could account for the dynamical origin of Sedna-like objects [3], [8].

2. Search Criteria

Our model requires a planet of mass (1–4) M_J and age 4.5 Gyr. There are at present no observed examples of the spectra of isolated objects of this nature. The theoretical models of Burrows *et al.* [2] give spectra for a variety of masses and ages, including 2 and 5 M_J of age 5 Gyr. We use these spectra as a guide for our search. The uncertainties in these spectra are estimated to be ~30% for the WISE bands w1 (3.4 microns) and w4 (22 microns) and are more uncertain for the w2 (4.6 microns) and w3 (12 microns) bands [1].

The most conspicuous feature of the spectra of planets in this mass and age range that are located in the outer Oort cloud is the absence of flux in w1. Also, the flux is essentially zero in both near IR (2mass) and visible wavelengths [2]. Only galactic latitudes greater than 5 degrees and only sources within 10 degrees of the maximum likelihood planet orbit plane, as defined in [7], were considered. Additional search constraints included the requirement of point sources, no 2mass associations, cc_flags = 0 in all bands , a signal to noise ratio > 5 in w2, w3 and w4, four detections in at least two bands and a magnitude difference (w2-w4) > 6. Various other combinations of constraints such as w1>w2>w3>w4 were also investigated. The common T dwarf search criterion of (w1-w2) > 2 was not considered useful since w1 is not expected to be detected for these objects.

3. Search Results

The sources that survived our flux search criteria (prior to comparison with the model colors) reflected a galactic latitude distribution, though there is a bias in the catalog since the 57% sky coverage disproportionately excluded galactic polar regions. Several of these sources were located in star forming regions.

None of the resulting candidates had (w2-w3) and (w3-w4) colors consistent with the models of Burrows, *et al.* [2]. A representative example is the source J160639.44-690808.1, which has colors (w2-w3) = 5.4 and (w3-w4) = 2.7. The predicted colors are approximately (w2-w3) = 1.5 and (w3-w4) = 6.8 for a 5 Gyr old 2 M_J object.

The observed w4 flux of 7.0 magnitudes is consistent with such an object orbiting in the Oort cloud.

The observed (w2-w3), (w3-w4) colors may be consistent with obscured active galactic nuclei (AGN) assuming that the observed marginal value of w1 is near the true value.

Ultimately, if a source with the appropriate band fluxes is found, followup observations measuring parallax and proper motion will be required to determine if the orbit plane is consistent with that modeled in [7].

4. Summary and Conclusions

Based on the theoretical models of Burrows *et al.* [2] we have searched the WISE Preliminary Catalog, which covers 57% of the sky, for evidence of a 4.5 Gyr old (1-4) M_J planet in the outer Oort cloud. The search was restricted to sources lying within 10 degrees of a previously identified great circle [7]. No candidate objects were identified. Future searches will be less restrictive, for example, allowing for nondetection in bands other than w1.

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