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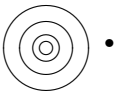
DISTANT EKOs



The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

IAUC 9050 announced that the IAU Committee on Small Bodies Nomenclature has approved the name for Quaoar's satellite: "Weywot". The name was chosen by the Native American Tongva tribe. The name Quaoar is the Tongva god of creation, and as mentioned in MPC 67220, "Weywot is the god of the sky in Tongva Mythology. Weywot was created by Quaoar when he sang the song of creation."

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There were 3 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2008 AP129, 2008 QB43, 2009 YE7

and 5 new Centaur/SDO discoveries:

2005 VD, 2009 HW77, 2008 ST291, 2009 YF7, 2009 YD7

Objects recently assigned numbers:

2007 OR10 = (225088)

Current number of TNOs: 1100 (including Pluto)
Current number of Centaurs/SDOs: 253
Current number of Neptune Trojans: 6

Out of a total of 1359 objects:

551 have measurements from only one opposition
539 of those have had no measurements for more than a year
290 of those have arcs shorter than 10 days

(for more details, see: `http://www.boulder.swri.edu/ekonews/objects/recov_stats.jpg`)

PAPERS ACCEPTED TO JOURNALS

A Single Sub-kilometre Kuiper Belt Object from a Stellar Occultation in Archival Data

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The Kuiper belt is a remnant of the primordial Solar System. Measurements of its size distribution constrain its accretion and collisional history, and the importance of material strength of Kuiper belt objects (KBOs). Small, sub-km sized, KBOs elude direct detection, but the signature of their occultations of background stars should be detectable. Observations at both optical and X-ray wavelengths claim to have detected such occultations, but their implied KBO abundances are inconsistent with each other and far exceed theoretical expectations. Here, we report an analysis of archival data that reveals an occultation by a body with a 500 m radius at a distance of 45 AU. The probability of this event to occur due to random statistical fluctuations within our data set is about 2%. Our survey yields a surface density of KBOs with radii larger than 250 m of $2.1^{+4.8}_{-1.7} \times 10^7$ deg^{-2}, ruling out inferred surface densities from previous claimed detections by more than 5 sigma. The fact that we detected only one event, firmly shows a deficit of sub-km sized KBOs compared to a population extrapolated from objects with $r > 50$ km. This implies that sub-km sized KBOs are undergoing collisional erosion, just like debris disks observed around other stars.

Published in: Nature, 462, 895 (2009 December 17)
For preprints, contact hilke.schlichting@gmail.com
or on the web at http://arxiv.org/abs/0912.2996
and http://www.nature.com/nature/journal/v462/n7275/full/nature08608.html

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Diffractive Microlensing - I. Flickering Planetesimals at the Edge of the Solar System

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Microlensing and occultation are generally studied in the geometric optics limit. However, diffraction may be important when recently discovered Kuiper Belt objects (KBOs) occult distant stars. In particular, the effects of diffraction become more important as the wavelength of the observation and the distance to the KBO increase. For sufficiently distant and massive KBOs or Oort cloud objects not only is diffraction important but so is gravitational lensing. For an object similar to Eris but located in the Oort cloud, the signature of gravitational lensing would be detected easily during an occultation and would give constraints on the mass and radius of the object.

To appear in: Monthly Notices of the Royal Astronomical Society
For preprints, contact heyl@phas.ubc.ca
or on the web at http://arxiv.org/abs/0910.3922

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Upper Limits on the Number of Small Bodies in Sedna-Like Orbits by the TAOS Project

J.H. Wang[1,2], M.J. Lehner[1,3,4], Z.W. Zhang[2], F.B. Bianco[3,4], C. Alcock[4], W.P. Chen[2], T. Axelrod[5], Y.I. Byun[6], N.K. Coehlo[7], K.H. Cook[8], R. Dave[4], I. de Pater[9], R. Porrata[9], D.W. Kim[6], S.K. King[1], T.Lee[1], H.C. Lin[2], J.J. Lissauer[10], S.L. Marshall[8,11], P. Protopapas[4], J.A. Rice[7], M.E. Schwamb[12], S.Y. Wang[1], and C.Y. Wen[1]

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We present the results of a search for occultation events by objects at distances between 100 and 1000 AU in lightcurves from the Taiwanese-American Occultation Survey (TAOS). We searched for consecutive, shallow flux reductions in the stellar lightcurves obtained by our survey between 7 February 2005 and 31 December 2006 with a total of $\sim 4.5 \times 10^9$ three-telescope simultaneous photometric measurements. No events were detected, allowing us to set upper limits on the number density as a function of size and distance of objects in Sedna-like orbits, using simple models.

Published in: Astronomical Journal, 138, 1893 (2009 December)
Preprint available on the web at `http://arxiv.org/abs/0910.5282`

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Rotations and Densities of Trans-Neptunian Objects

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Context. Trans-Neptunian objects (TNOs) represent a new frontier in the study of our Solar System. In particular, the investigation of their rotational properties can provide important hints about their internal structure and collisional evolution.

Aims. We expand the limited sample of TNOs with known rotation rates, and improve the knowledge of the physical nature of these bodies.

Methods. We carried out photometric observations of 5 TNOs — (144897) 2004 UX_{10}, (145451) 2005 RM_{43}, (145453) 2005 RR_{43}, 2003 UZ_{117}, and 2003 UZ_{413} — using the New Technology Telescope of the European Southern Observatory.

Results. We determined the spin rates of four targets, while only an estimation of the period was possible for 2003 UZ_{117}.

Conclusions. From the computed rotational periods and the obtained light curve amplitudes of four TNOs, we derived the lower limit to their axis ratio a/b, and hence estimated their density. Combining our new results with literature data, we investigated the density statistics of the small bodies of the outer Solar System.

Published in: Astronomy and Astrophysics, 508, 451 (2009 December)

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(47171) 1999 TC_{36}, A Transneptunian Triple

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We present new analysis of HST images of (47171) 1999 TC_{36} that confirm it as a triple system. Fits to the point-spread function consistently show that the apparent primary is itself composed of two similar-sized components. The two central components, A1 and A2, can be consistently identified in each of nine epochs spread over seven years of time. In each instance the component separation, ranging from 0.023 ± 0.002 to 0.031 ± 0.003 arcsec, is roughly one half of the Hubble Space Telescopes diffraction limit at 606 nm. The orbit of the central pair has a semi-major axis of $a \sim 867$ km with a period of $P \sim 1.9$ days. These orbital parameters yield a system mass that is consistent with $M_{sys} = 12.75 \pm 0.06\ 10^{18}$ kg derived from the orbit of the more distant secondary, component B. The diameters of the three components are $d_{A1} = 286^{+45}_{-38}$ km, $d_{A2} = 265^{+41}_{-35}$ km and $d_B = 139^{+22}_{-18}$ km. The relative sizes of these components are more similar than in any other known multiple in the solar system. Taken together, the diameters and system mass yield a bulk density of $\rho = 542^{+317}_{-211}$ kg m^{-3}. HST Photometry shows that component B is variable with an amplitude of $\geq 0.17 \pm 0.05$ magnitudes. Components A1 and A2 do not show variability larger than 0.08 ± 0.03 magnitudes approximately consistent with the orientation of the mutual orbit plane and tidally-distorted equilibrium shapes. The system has high specific angular momentum of $J/J' = 0.93$, comparable to most of the known Transneptunian binaries.

To appear in: Icarus

Preprints available on the web at `http://arxiv.org/abs/0912.2074`

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The Trans-Neptunian Object (42355) Typhon: Composition and Dynamical Evolution

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Context. The scattered disk object (42355) Typhon showed interesting features in visible and near-infrared spectra. In particular, the visible spectra shows evidence for aqueously altered materials.

Aims. This article presents a possible origin for absorption features on the surface of (42355) Typhon due to an episode of aqueous alteration, and seeks to understand this event in the context of its dynamical evolution.

Methods. We observed (42355) Typhon at the ESO / Very Large Telescope using FORS2 and ISAAC on telescope unit 1, and SINFONI on telescope unit 4. We compare these data with those previously published, in order to confirm features found in the visible and near infrared spectra, and to study possible surface heterogeneities. We interpret the surface composition using the Hapke radiative transfer model on the whole available spectral range $\sim 0.5 - 2.4$ μm.

To complete the portrait of (42355) Typhon, we followed its dynamical evolution using the code EVORB v.13 for 20 Myr.

Results. We confirm the detection of a subtle absorption feature in the visible at ~ 0.6 μm, which we interpret as due to water-altered silicates. In the near infrared we confirm the presence of water ice, by the 2.0 μm absorption feature. The best fit models to our data point the presence of water ice.

Conclusions. (42355) Typhon is too small to have suffered water alteration, but this event could happen in a larger parent body from which (42355) Typhon is a remnant after a catastrophic disruption.

To appear in: Astronomy & Astrophysics
For preprints, contact `aalvarez@eso.org`

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Neptune Trojans and Plutinos: Colors, Sizes, Dynamics, and their Possible Collisions

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Neptune Trojans and Plutinos are two sub-populations of Trans-Neptunian Objects located in the 1:1 and the 3:2 mean motion resonances with Neptune, respectively, and therefore protected from close encounters with the planet. However, the orbits of these two kinds of objects may cross very often, allowing a higher collisional rate between them than with other kinds of Trans-Neptunian Objects and a consequent and size distribution alteration of the two sub-populations.

Observational colors and absolute magnitudes of Neptune Trojans and Plutinos show that: i) there are no intrinsically bright (large) Plutinos at small inclinations; ii) there is an apparent excess of blue and intrinsically faint (small) Plutinos; and iii) Neptune Trojans possess the same blue colors as Plutinos within the same (estimated) size range do.

For the present sub-populations we analyze the most favorable conditions for close encounters / collisions to occur and address if there could be a link between those encounters and the sizes and/or colors of Plutinos and Neptune Trojans. We also perform a simultaneous numerical simulation of the outer Solar System over 1 Gyr for all these bodies in order to estimate their collisional rate.

We conclude that orbital overlap between Neptune Trojans and Plutinos is favored for Plutinos with high libration amplitudes, high eccentricities and low inclinations. Additionally, with the assumption that the collisions can be disruptive creating smaller objects not necessarily with similar colors, the present high concentration of small Plutinos at low inclinations can thus be a consequence of a collisional interaction with Neptune Trojans and such hypothesis should be further analyzed.

To appear in: Astronomy & Astrophysics
For preprints, contact `correia@ua.pt`
or on the web at `http://arxiv.org/abs/0910.0865`

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Phase Curves of Nine Trojan Asteroids over a Wide Range of Phase Angles

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We have observed well-sampled phase curves for nine Trojan asteroids in B-, V-, and I-bands. These were constructed from 778 magnitudes taken with the 1.3-m telescope on Cerro Tololo as operated by a service observer for the SMARTS consortium. Over our typical phase range of 0.2-10°, we find our phase curves to be adequately described by a linear model, for slopes of 0.04-0.09 mag/° with average uncertainty less than 0.02 mag/°. (The one exception, 51378 (2001 AT33), has a formally negative slope of -0.02±0.01 mag/°.) These slopes are too steep for the opposition surge mechanism to be shadow hiding (SH), so we conclude that the dominant surge mechanism must be coherent backscattering (CB). In a detailed comparison of surface properties (including surge slope, $B-R$ color, and albedo), we find that the Trojans have surface properties similar to the P and C class asteroids prominent in the outer main belt, yet they have significantly different surge properties (at a confidence level of 99.90%). This provides an imperfect argument against the traditional idea that the Trojans were formed around Jupiters orbit. We also find no overlap in Trojan properties with either the main belt asteroids or with the small icy bodies in the outer Solar System. Importantly, we find that the Trojans are indistinguishable from other small bodies in the outer Solar System that have lost their surface ices (such as the gray Centaurs, gray Scattered Disk Objects, and dead comets). Thus, we find strong support for the idea that the Trojans originally formed as icy bodies in the outer Solar System, were captured into their current orbits during the migration of the gas giant planets, and subsequently lost all their surface ices.

To appear in: Icarus

For preprints, contact mws@lsu.edu

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Colors and Taxonomy of Centaurs and Trans-Neptunian Objects

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Context. The study of the surface properties of Centaurs and Trans-Neptunian Objects (TNOs) provides essential information about the early conditions and evolution of the outer Solar System. Due to the faintness of most of these distant and icy bodies, photometry currently constitutes the best technique to survey a statistically significant number of them.

Aims. Our aim is to investigate color properties of a large sample of minor bodies of the outer Solar System, and set their taxonomic classification.

Methods. We carried out visible and near-infrared photometry of Centaurs and TNOs, making use, respectively, of the FORS2 and ISAAC instruments at the Very Large Telescope (European Southern Observatory). Using G-mode analysis, we derived taxonomic classifications according to the Barucci et al. (2005a) system.

Results. We report photometric observations of 31 objects, 10 of them have their colors reported for the first time ever. 28 Centaurs and TNOs have been assigned to a taxon.

Conclusions. We combined the entire sample of 38 objects taxonomically classified in the framework of our programme (28 objects from this work; 10 objects from DeMeo et al. 2009a) with previously classified TNOs and Centaurs, looking for correlations between taxonomy and dynamics. We compared our photometric results to literature data, finding hints of heterogeneity for the surfaces of 4 objects.

To appear in: Astronomy and Astrophysics
Preprints available on the web at `http://arxiv.org/abs/0912.2621`

PAPERS RECENTLY SUBMITTED TO JOURNALS

Searching for Sub-kilometer TNOs using Pan-STARRS Video Mode Lightcurves: Preliminary Study and Evaluation using Engineering Data

J.-H. Wang[1,2], P. Protopapas[3,4], W.-P. Chen[2], C. R. Alcock[3], W. S. Burgett[5], T. Dombeck[6], T. Grav[7], J. S. Morgan[5], P. A. Price[5], and J. L. Tonry[5]

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Submitted to: The Astronomical Journal
Preprints available on the web at `http://arxiv.org/abs/0910.5598`

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The Size, Density, and Formation of the Orcus-Vanth System in the Kuiper Belt

M.E. Brown[1], D. Ragozzine[1,2], J. Stansberry[3], and W.C. Fraser[1]

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Submitted to: The Astronomical Journal
For preprints, contact `mbrown@caltech.edu`
or on the web at `http://arxiv.org/abs/0910.4784`

OTHER PAPERS OF INTEREST

Will the Large Synoptic Survey Telescope Detect Extra-solar Planetesimals Entering the Solar System?

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The Astrophysical Journal, 704, 733 (2009 October 10)

For preprints, contact amaya@astro.princeton.edu

or on the web at http://arXiv.org/abs/0908.3948

and http://www.astro.princeton.edu/~amaya/publications/publications.html

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CONFERENCE CONTRIBUTIONS

The Sizes of Kuiper Belt Objects

Pedro Lacerda[1]

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To appear in: proceedings of "The Space Infrared Telescope for Cosmology & Astrophysics: Revealing the Origins of Planets and Galaxies"

Preprints available on the web at http://arxiv.org/abs/0911.0004

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The Dark Red Spot on KBO Haumea

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To appear in: proceedings of IAU 2009 Symposium S263 "Icy Bodies of the Solar System"

Preprints available on the web at http://arxiv.org/abs/0911.0009

The *Distant EKOs* Newsletter is dedicated to provide researchers with easy and rapid access to current work regarding the Kuiper belt (observational and theoretical studies), directly related objects (e.g., Pluto, Centaurs), and other areas of study when explicitly applied to the Kuiper belt.

We accept submissions for the following sections:
⋆ Abstracts of accepted papers
⋆ Titles of submitted (but not yet accepted) papers and conference articles
⋆ Thesis abstracts
⋆ Short articles, announcements, or editorials
⋆ Status reports of on-going programs
⋆ Requests for collaboration or observing coordination
⋆ Table of contents/outlines of books
⋆ Announcements for conferences
⋆ Job advertisements
⋆ General news items deemed of interest to the Kuiper belt community

A LaTeX template for submissions is appended to each issue of the newsletter, and is sent out regularly to the e-mail distribution list. Please use that template, and send your submission to:

`ekonews@boulder.swri.edu`

The *Distant EKOs* Newsletter is available on the World Wide Web at:

`http://www.boulder.swri.edu/ekonews`

Recent and back issues of the newsletter are archived there in various formats. The web pages also contain other related information and links.

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Moving ... ??

If you move or your e-mail address changes, please send the editor your new address. If the newsletter bounces back from an address for three consecutive issues, the address will be deleted from the mailing list. All address changes, submissions, and other correspondence should be sent to:

`ekonews@boulder.swri.edu`