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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

More binaries...lots more...

In IAUC 8811, 8814, 8815, and 8816, Noll et al. report satellites of five TNOs from HST observations:

- (123509) 2000 WK183, separation = 0.080 arcsec, magnitude difference = 0.4 mag
- 2002 WC19, separation = 0.090 arcsec, magnitude difference = 2.5 mag
- 2002 GZ31, separation = 0.070 arcsec, magnitude difference = 1.0 mag
- 2004 PB108, separation = 0.172 arcsec, magnitude difference = 1.2 mag
- (60621) 2000 FE8, separation = 0.044 arcsec, magnitude difference = 0.6 mag

In IAUC 8812, Brown and Suer report satellites of four TNOs from HST observations:

- (50000) Quaoar, separation = 0.35 arcsec, magnitude difference = 5.6 mag
- (55637) 2002 UX25, separation = 0.164 arcsec, magnitude difference = 2.5 mag
- (90482) Orcus, separation = 0.25 arcsec, magnitude difference = 2.7 mag
- 2003 AZ84, separation = 0.22 arcsec, magnitude difference = 5.0 mag

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There were *no* new TNO, SDO, Centaur, or Neptune Trojan discoveries announced or reclassifications of objects since the previous issue of *Distant EKOs*.

Objects recently assigned numbers:
1999 RA216 = (148112)
2000 CR105 = (148209)
2001 CZ31 = (150642)
2001 UQ18 = (148780)
2001 XA255 = (148975)
2002 VA131 = (149349)
2002 VS130 = (149348)
2003 QZ91 = (149560)

Current number of TNOs: 1026 (including Pluto)
Current number of Centaurs/SDOs: 195
Current number of Neptune Trojans: 5

Out of a total of 1226 objects:
512 have measurements from only one opposition
463 of those have had no measurements for more than a year
248 of those have arcs shorter than 10 days
(for more details, see: `http://www.boulder.swri.edu/ekonews/objects/recov_stats.gif`)

PAPERS ACCEPTED TO JOURNALS

Volatile Loss and Retention on Kuiper Belt Objects

E.L. Schaller[1] **and M.E. Brown**[1]

[1] California Institute of Technology, Division of Geological and Planetary Sciences, Pasadena, CA 91125, USA

Recent discoveries have shown that the very largest Kuiper belt objects – Eris, 2005 FY9 and Sedna – are coated in methane, and may contain other volatile ices as well. New detailed observations show that even within this class of volatile-rich bodies unexpected differences exist in their surface compositions. 2005 FY9, a body approximately 60% the size of Pluto, with a reflectance spectrum similarly dominated by methane, has a surface depleted in molecular nitrogen by at least an order in magnitude with respect to Pluto. We find that the existence this new class of volatile-rich objects, the lack of volatiles on most Kuiper belt objects, and even the otherwise peculiar surface of 2005 FY9 can be explained as a consequence of atmospheric escape of volatile compounds. While previous studies of the surface compositions of objects in the Kuiper belt have found no explainable patterns, atmospheric escape appears to provide a first-order explanation of the range of surface spectra seen on bodies in the outer solar system.

To appear in: Astrophysical Journal
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Transneptunian Object 2003 UB313 as a Source of Comets

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The possibility of interrelation between long-period comets and 2003 UB313, a recently discovered large Kuiper Belt body, is investigated. For this purpose, 78 objects crossing the plane of motion of this body at distances from 37.8 to 97.6 AU have been selected from 860 long-period comets. The overpopulation of comets with this characteristic is also considered. The plane of motion of 2003 UB313 is compared with the orbital planes of other objects in number of comet crossings in the specified distance interval or in some parts of it. A statistically significant overpopulation of elliptic and intermediate comets with the corresponding orbital nodes has been established. Recently discovered and absolutely faint comets show the best effect in this sense. The same is also true for comets with osculating eccentricities $e < 1$. A similar result is also obtained for comets with "original" $a^1 > 0.010000$. It is hypothesized that the 2003 UB313 family is present among the 78 comets. Four of them have aphelion distances from 37.8 to 97.6 AU. An ellipticity is traceable in the distribution of some of the 78 distant nodes. This may be considered as a further argument for the suggested hypothesis. Generally, the body 2003 UB313 may be assumed to play a prominent role in injecting observable comets from the transneptunian region.

Published in: Solar System Research, 41, 46 (2007 February)
[Astronomicheskii Vestnik, 41, 51]

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The Formation of Ice Giants in a Packed Oligarchy: Instability and Aftermath

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[2] Hubble Fellow

[3] UC Berkeley

As many as 5 ice giants—Neptune-mass planets composed of ∼90% ice and rock and ∼10% hydrogen—are thought to form at heliocentric distances of ∼10–25 AU on closely packed orbits spaced ∼5 Hill radii apart. Such oligarchies are ultimately unstable. Once the parent disk of planetesimals is sufficiently depleted, oligarchs perturb one another onto crossing orbits. We explore both the onset and the outcome of the instability through numerical integrations, including dynamical friction cooling of planets by a planetesimal disk whose properties are held fixed. To trigger instability and the ejection of the first ice giant in systems having an original surface density in oligarchs of $\Sigma \sim 1$ gm/cm^2, the disk surface density σ must fall below ∼0.1 gm/cm^2. Ejections are predominantly by Jupiter and occur within $\sim 10^7$ yr. To eject more than 1 oligarch requires $\sigma \lesssim 0.03$ gm/cm^2. For certain choices of σ and initial semi-major axes of planets, systems starting with up to 4 oligarchs in addition to Jupiter and Saturn can readily yield solar-system-like outcomes in which 2 surviving ice giants lie inside 30 AU and have their orbits circularized by dynamical friction. Our findings support the idea that planetary systems begin in more crowded and compact configurations, like those of shear-dominated oligarchies. In contrast to previous studies, we identify $\sigma \lesssim 0.1\Sigma$ as the regime relevant for understanding the evolution of the outer solar system, and we encourage future studies to concentrate on this regime while relaxing our assumption of a fixed planetesimal disk. Whether evidence of the instability can be found in Kuiper belt objects (KBOs) is unclear, since in none of our simulations do marauding oligarchs excite as large a proportion of KBOs having inclinations $\gtrsim 20°$ as is observed.

To appear in: The Astrophysical Journal

For preprints, contact `eford@cfa.harvard.edu`

or on the web at `astro.berkeley.edu/~echiang/ppp/ppp.html`

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A Dynamical and Observational Study of an Unstable TNO: (59358) 1999 CL$_{158}$

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The physical surface properties of a trans-Neptunian Object is believed to be mainly produced as a result of interplay between irradiation from different kinds of cosmic rays and collisions. Objects recently resurfaced by collisions are likely to have very different physical properties from those of the bulk population. In particular, pristine ices from the interior are expected to be present on the surface. A possible way to identify a trans-Neptunian object that has suffered a major collision is by investigating the lifetime of the orbit near its present location. If the lifetime is very short, a physical encounter is a possible way by which the TNO has evolved into such a short lived orbit.

The goal of this investigation is to search for tracers of a young surface on objects with very short orbital lifetimes in the trans-Neptunian Belt. We are looking for any evidence that indicates that

they reached their current unstable orbits through collisions. In particular, we have studied the case of (59358) 1999 CL_{158}, a trans-Neptunian object that currently has the most chaotic orbit in the Classical Belt.

By numerically integration its orbit, we estimate that (59358) 1999 CL_{158} has resided near its location for about ∼10 Myr. We have also obtained a near-infrared spectrum of (59358) 1999 CL_{158} in the region between 1.43–1.96 microns using the near infrared imager and spectrograph, NIRI, at Gemini North 8-m telescope. These NIR observations are of the faintest and smallest TNO so far observed.

We present the results of the search of ice-bands, such as CH_4 and H_2O, having found evidence of the presence of the first mentioned molecule. The detection of methane implies that it must be an abundant component of this object. Methane is also evidence of a young surface, therefore we conclude that it is likely that (59358) 1999 CL_{158} has experienced a recent collision or collisions.

To appear in: Astronomy and Astrophysics
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The Search for Distant Objects in the Solar System using Spacewatch

J.A. Larsen[1], E.S. Roe[1,2], C.E. Albert[1], A.S. Descour[3,4], R.S. McMillan[3], A.E. Gleason[5], R. Jedicke[6], M. Block[3], T.H. Bressi[3], K.C. Cochran[3], T. Gehrels[3], J.L. Montani[3], M.L. Perry[3], M.T. Read[3], J.V. Scotti[3], and A.F. Tubbiolo[3]

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We have completed a low-inclination ecliptic survey for distant and slow-moving bright objects in the outer solar system. This survey used data taken over 34 months by the University of Arizona's Spacewatch Project based at Steward Observatory, Kitt Peak. Spacewatch revisits the same sky area every three to seven nights in order to track cohorts of main-belt asteroids. This survey used a multiple-night detection scheme to extend our rate sensitivity to as low as 0.012 arcsec hr^{-1}. When combined with our plate scale and flux sensitivity ($V \approx 21$), this survey was sensitive to Mars-sized objects out to 300 AU and Jupiter-sized planets out to 1200 AU. The survey covered approximately 8000 deg^2 of raw sky, mostly within 10° of the ecliptic but away from the Galactic center. An automated motion-detection program was modified for this multinight search and processed approximately 2 terabytes of imagery into motion candidates. This survey discovered 2003 MW_{12}, currently the tenth largest classical Kuiper Belt object. In addition, several known large Kuiper Belt objects and Centaurs were detected, and the detections were used with a model of our observational biases to make population estimates as a check on our survey efficiency. We found no large objects at low inclinations despite having sufficient sensitivity in both flux and rate to see them out as far as 1200 AU. For low inclinations, we can rule out more than one to two Pluto-sized objects out to 100 AU and one to two Mars-sized objects to 200 AU.

Published in: The Astronomical Journal, 133, 1247 (2007 April)

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Irregular Satellites of the Planets: Capture Processes in the Early Solar System

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All four giant planets in the Solar system possess irregular satellites, characterized by large, highly eccentric and/or inclined orbits that are distinct from the nearly circular, uninclined orbits of the regular satellites. This difference can be traced directly to different modes of formation. Whereas the regular satellites grew by accretion within circumplanetary disks, the irregular satellites were captured from initially heliocentric orbits at an early epoch. Recently, powerful survey observations have greatly increased the number of known irregular satellites, permitting a fresh look at the group properties of these objects and motivating a re-examination of the mechanisms of capture. None of the suggested mechanisms, including gas-drag, pull-down, and three-body capture, convincingly fit the group characteristics of the irregular satellites. The sources of the satellites also remain unidentified.

To appear in: Annual Reviews of Astronomy and Astrophysics, Volume 45

Preprints available on the web at `http://www.ifa.hawaii.edu/~jewitt/papers/2007/JH07.pdf`

PAPERS RECENTLY SUBMITTED TO JOURNALS

Millisecond Dips in the RXTE/PCA Light Curve of Sco X-1 and TNO Occultation

Hsiang-Kuang Chang[1,2], Jau-Shian Liang[1], Chih-Yuan Liu[2], and Sun-Kun King[3]

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Submitted to: Monthly Notices of the Royal Astronomical Society

For preprints, contact `hkchang@phys.nthu.edu.tw`

or on the web at `http://arxiv.org/abs/astro-ph/0701850`

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The Water Ice Rich Surface of (145453) 2005 RR_{43}: A Case for a Population of Trans-Neptunian Objects?

N. Pinilla-Alonso [1], J. Licandro[2,3], R. Gil-Hutton[4], and R. Brunetto[5,6]

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Submitted to: Astronomy & Astrophysics

For preprints, contact `npinilla@tng.iac.es`

or online at `http://arxiv.org/abs/astro-ph/0703098`

OTHER PAPERS OF INTEREST

Is the Outer Solar System Chaotic?

Wayne B. Hayes[1]

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Preprints available online at `http://arxiv.org/abs/astro-ph/0702179`

CONFERENCE CONTRIBUTIONS

On the Dynamics of Resonant Kuiper Belt Objects

Ing-Guey Jiang[1] **and Li-Chin Yeh**[2]

[1] Department of Physics, National Tsing-Hua University, Hsin-Chu, Taiwan

[2] Department of Applied Mathematics, National Hsinchu University of Education, Hsin-Chu, Taiwan

To appear in: the proceedings of the 9th Asian-Pacific Regional IAU Meeting
Preprints available on the web at `http://arxiv.org/abs/astro-ph/0701807`

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Daniel Mege (`daniel.mege@univ-nantes.fr`) sent out the following announcement:

> Just to let you know that the 19 presentations at the TNO workshop held in Nantes, France, on Jan 11–12 in connexion with the New Horizons mission are now online. The aim of the workshop was taking stock of the current astronomical, geophysical, and geological activities related to the Pluto system and the TNOs in the French research community, and also introducing the New Horizons instruments and sequence of events to the participants.

The presentations can be found online at:
`http://www.sciences.univ-nantes.fr/geol/KuiperBelt/downloads.html`

BOOKS

Below are some chapters from the "Kuiper Belt" book (M.A. Barucci, H. Boehnhardt,D. Cruikshank, and A. Morbidelli, eds.; University of Arizona Press, Tucson, 2007). I will include other chapters in later issues of the newsletter if they are submitted to me, as well as an outline of the full book when it is published.

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Physical Properties of Kuiper Belt and Centaur Objects: Constraints from Spitzer Space Telescope

John Stansberry[1], Will Grundy[2], Michael E. Brown[3], Dale Cruikshank[4], John Spencer[5], David Trilling[1], and Jean-Luc Margot[6]

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Detecting heat from minor planets in the outer solar system is challenging, yet it is the most efficient means for constraining the albedos and sizes of Kuiper Belt Objects (KBOs) and their progeny, the Centaur objects. These physical parameters are critical, e.g., for interpreting spectroscopic data, deriving densities from the masses of binary systems, and predicting occultation tracks. Here we summarize *Spitzer Space Telescope* observations of 47 KBOs and Centaurs at wavelengths near 24 and 70 μm. We interpret the measurements using a variation of the Standard Thermal Model (STM) to derive the physical properties (albedo and diameter) of the targets. We also summarize the results of other efforts to measure the albedos and sizes of KBOs and Centaurs. The three or four largest KBOs appear to constitute a distinct class in terms of their albedos. From our Spitzer results, we find that the geometric albedo of KBOs and Centaurs is correlated with perihelion distance (darker objects having smaller perihelia), and that the albedos of KBOs (but not Centaurs) are correlated with size (larger KBOs having higher albedos). We also find hints that albedo may be correlated with with visible color (for Centaurs). Interestingly, if the color correlation is real, redder Centaurs appear to have higher albedos. Finally, we briefly discuss the prospects for future thermal observations of these primitive outer solar system objects.

For preprints, contact `stansber@as.arizona.edu`
or on the web at `http://arXiv.org/abs/astro-ph/0702538`

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Binaries in the Kuiper Belt

Keith S. Noll[1], William M. Grundy[2], Eugene I. Chiang[3], Jean-Luc Margot[4], and Susan D. Kern[1]

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Binaries have played a crucial role many times in the history of modern astronomy and are doing so again in the rapidly evolving exploration of the Kuiper Belt. The large fraction of transneptunian

objects that are binary or multiple, 48 such systems are now known, has been an unanticipated windfall. Separations and relative magnitudes measured in discovery images give important information on the statistical properties of the binary population that can be related to competing models of binary formation. Orbits, derived for 13 systems, provide a determination of the system mass. Masses can be used to derive densities and albedos when an independent size measurement is available. Angular momenta and relative sizes of the majority of binaries are consistent with formation by dynamical capture. The small satellites of the largest transneptunian objects, in contrast, are more likely formed from collisions. Correlations of the fraction of binaries with different dynamical populations or with other physical variables have the potential to constrain models of the origin and evolution of the transneptunian population as a whole. Other means of studying binaries have only begun to be exploited, including lightcurve, color, and spectral data. Because of the several channels for obtaining unique physical information, it is already clear that binaries will emerge as one of the most useful tools for unraveling the many complexities of transneptunian space.

Preprints available on the web at `http://arxiv.org/abs/astro-ph/0703134`

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Extra-Solar Kuiper Belt Dust Disks

Amaya Moro-Martín[1], Mark C. Wyatt[2], Renu Malhotra[3] and David E. Trilling[4]

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The dust disks observed around mature stars are evidence that plantesimals are present in these systems on spatial scales that are similar to that of the asteroids and the KBOs in the Solar System. These dust disks (a.k.a. “debris disks”) present a wide range of sizes, morphologies and properties. It is inferred that their dust mass declines with time as the dust-producing planetesimals get depleted, and that this decline can be punctuated by large spikes that are produced as a result of individual collisional events. The lack of solid state features indicate that, generally, the dust in these disks have sizes greater than approximately 10 μm, but exceptionally, strong silicate features in some disks suggest the presence of large quantities of small grains, thought to be the result of recent collisions. Spatially resolved observations of debris disks show a diversity of structural features, such as inner cavities, warps, offsets, brightness asymmetries, spirals, rings and clumps. There is growing evidence that, in some cases, these structures are the result of the dynamical perturbations of a massive planet. Our Solar System also harbors a debris disk and some of its properties resemble those of extra-solar debris disks. From the cratering record, we can infer that its dust mass has decayed with time, and that there was at least one major “spike” in the past during the Late Heavy Bombardment. This offers a unique opportunity to use extra-solar debris disks to shed some light in how the Solar System might have looked in the past. Similarly, our knowledge of the Solar System is influencing our understanding of the types of processes which might be at play in the extra-solar debris disks.

For preprints, contact `amaya@astro.princeton.edu`

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.

Distant EKOs is not a refereed publication, but is a tool for furthering communication among people interested in Kuiper belt research. Publication or listing of an article in the newsletter or the web page does not constitute an endorsement of the article's results or imply validity of its contents. When referencing an article, please reference the original source; *Distant EKOs* is not a substitute for peer-reviewed journals.

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`