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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

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CONTENTS

NEWS & ANNOUNCEMENTS

Big TNO is big news: on the first day of the DPS meeting the discovery of 2002 LM60 (unofficially named "Quaoar") was announced by Brown and Trujillo. As the press release states, this is "the largest object in the solar system seen since the discovery of Pluto 72 years ago." The diameter of 1250 km was measued directly by HST as well as from thermal observations giving an albedo of about 10%. News release and other information at:
`http://oposite.stsci.edu/pubinfo/pr/2002/17/`
`http://www.gps.caltech.edu/~chad/quaoar/`
Other prediscovery images dating back to 1956 have been subsequently found, so that it will likely be numbered and officially named soon.

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Close on the heels of the announcement of 2002 LM60 are two more bright (and therefore, possibly big) objects:
2002 TC302 (discovered by Trujillo et al.), a SDO with $H = 3.7$ making it the brightest/biggest known member of the scattered disk;
2002 TX300 (discovered by Helin et al.), with $H = 3.4$, making it one of the top four brightest/biggest TNOs. It also has prediscovery images dating back to 1954.

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Bertoldi and collaborators report the measurements of sizes and albedoes of more TNOs, ranging from 675 km and 3.5% reflectivity (for 1999 TC26) to 1200 km and 12% reflectivity (for 2002 LM60 = Quaoar). The press release and tabulated measurements are online at:
`http://www.mpifr-bonn.mpg.de/staff/bertoldi/kbo/pr_kbo_e.html`

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The Kuiper belt may be a cosmic-ray generator. The abstract of the GRL paper by Schwadron et al. is included in this issue, and press releases can be found at:
`http://www.agu.org/sci_soc/prrl/prrl0235.html`
`http://www.swri.org/9what/releases/cosmic.htm`

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A workshop was held at the Birmingham DPS meeting to discuss the search for KBO flyby targets for the New Horizons Pluto/KBO mission. A report on the results of the workshop can be found at `http://www.lowell.edu/users/spencer/nhkbosearch/`

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There were 53 new TNO discoveries announced since the previous issue of the *Distant EKOs* Newsletter:

> 2002 LM60, 2002 PD149, 2002 PE149, 2002 PF149, 2002 PG150, 2002 PH149, 2002 PJ149, 2002 PK149, 2002 PM149, 2002 PN147, 2002 PN149, 2002 PO149, 2002 PP149, 2002 PQ145, 2002 PQ149, 2002 PR152, 2002 PS152, 2002 PT152, 2002 PU152, 2002 PV152, 2002 PW152, 2002 PX152, 2002 PA153, 2002 PB153, 2002 PC153, 2002 PD153, 2002 PE153, 2002 PF153, 2002 PG153, 2002 PY152, 2002 PZ152, 2002 PJ153, 2002 PK153, 2002 PL153, 2002 PM153, 2002 PN153, 2002 PO153, 2002 PP153, 2002 TX300, 2002 TA301, 2002 TB301, 2002 TC301, 2002 TD301, 2002 TE301, 2002 TF301, 2002 TG301, 2002 TH301, 2002 TJ301, 2002 TL301, 2002 TM301, 2002 TZ300, 2002 UX25, 2002 PA149

and 3 new Centaur/SDO discoveries:

> 2002 PQ152, 2002 TK301, 2002 TC302

Reclassified objects:
2001 QW297 (TNO $\rightarrow$ SDO)
2000 OP67 (SDO $\rightarrow$ TNO)
2001 UQ18 (SDO $\rightarrow$ TNO)

Objects recently assigned numbers:
1999 TC36 = (47171)
2000 GN171 = (47932)

Current number of TNOs: 617 (and Pluto & Charon, and 7 other TNO binary companions)
Current number of Centaurs/SDOs: 122

PAPERS ACCEPTED TO JOURNALS

Visible and Infrared Photometry of Kuiper Belt Objects: Searching for Evidence of Trends

N. McBride[1], S.F. Green[1], J.K. Davies[2], D.J. Tholen[3], S.S. Sheppard[3], R.J. Whiteley[4], and J.K. Hillier[5]

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We present new visible–infrared $(V-J)$ observations of 17 Kuiper Belt objects. 14 of the objects were observed in the visible and infrared wavebands simultaneously to limit the effects of lightcurve variations. Combining these data with our previously published visible–infrared data provides a dataset of 29 objects, 25 of which offer simultaneous $V-J$ colors. We examine the resulting dataset for evidence of relationships between physical properties and orbital characteristics. We find no evidence of a color–size relationship (as previously suspected) at least over the size range sampled. The dataset supports the trend, reported elsewhere, that there is a predominance of red material on the surfaces of objects having perihelia beyond 40 AU. Our data are also supportive, albeit weakly, of a reported correlation between inclination and color in the classical Kuiper Belt — although it is perhaps more correct to say that our data show that there appears to be a lack of low inclination blue objects. Our $V-J$ colors appear broadly correlated with published optical colors, thus suggesting that the surfaces of Kuiper Belt objects are subject to a single reddening agent.

To appear in: Icarus
For preprints, contact `n.m.mcbride@open.ac.uk`
or on the web at `http://www.roe.ac.uk/~jkd/V-J-2-paper.pdf`

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Statistical Methods for Detecting Stellar Occultations by Kuiper Belt Objects: The Taiwanese-American Occultation Survey

Chyng-Lan Liang[1], John A. Rice[1], Imke de Pater[2], Charles Alcock[3], Tim Axelrod[4], Andrew Wang[5], and Stuart Marshall[6]

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The Taiwanese-American Occultation Survey (TAOS) will detect objects in the Kuiper Belt, by measuring the rate of occultations of stars by these objects, using an array of three to four 50 cm wide-field robotic telescopes. Thousands of stars will be monitored, resulting in hundreds of millions of photometric measurements per night. To optimize the success of TAOS, we have investigated various methods of gathering and processing the data and developed statistical methods for detecting occultations. In this paper we discuss these methods. The resulting estimated detection efficiencies will be used to guide the choice of various operational parameters determining the mode of actual observation when the telescopes come on line and begin routine observations. In particular we show how real-time detection algorithms may be constructed, taking advantage of having multiple telescopes. We also discuss a retrospective method for estimating the rate at which occultations occur.

To appear in: Statistical Science

Preprints available by anonymous ftp at

`ftp://floris.berkeley.edu/pub/nobackup/taos/chyng_taos_paper.pdf`

or on the web at `http://www.arxiv.org/abs/astro-ph/0209509`

or tech report numer 626 at `http://www.stat.berkeley.edu/tech-reports/`

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The Outer Source of Pickup Ions and Anomalous Cosmic Rays

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[2] Department of Atmospheric, Oceanic and Space Science, The University of Michigan, Ann Arbor, MI, USA

The traditionally accepted source of Anomalous Cosmic Rays (ACRs) is neutral atoms penetrating the heliosphere from the local interstellar cloud (LIC). The ACR composition should be depleted in easily ionized atoms such as C, Si, and Fe. However, significant fluxes of these ions are observed in ACRs and their source has not been previously identified. We show that there is an "outer source" of pickup ions, and hence ACRs, caused by sputtered atoms (subsequently ionized and picked up by the solar wind) from small grains generated via collisions of objects in the Edgeworth-Kuiper Belt. The outer source accounts for the abundance and composition of the additional population of ACRs. The discovery that ACRs are generated from material in the Edgeworth-Kuiper Belt provides an exciting new tool for understanding the mass distribution and composition of the Edgeworth-Kuiper Belt, and for probing the plasma-dust interactions in stellar environments.

Published in: Geophysical Research Letters, 29 (20), 1993

For preprints, contact `nschwadron@swri.edu`

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A Symplectic Mapping Model for the Study of 2:3 Resonant Trans-Neptunian Motion

K.G. Hadjifotinou[1] **and John D. Hadjidemetriou**[1]

[1] Department of Physics, University of Thessaloniki, 541 24 Thessaloniki, Greece

A symplectic mapping is constructed for the study of the dynamical evolution of Edgeworth-Kuiper belt objects near the 2:3 mean motion resonance with Neptune. The mapping is six-dimensional and is a good model for the Poincaré map of the "real" system, that is, the spatial elliptic restricted three-body problem at the 2:3 resonance, with the Sun and Neptune as primaries. The mapping model is based on the averaged Hamiltonian, corrected by a semianalytic method so that it has the basic topological properties of the phase space of the real system both qualitatively and quantitatively. We start with two dimensional motion and then we extend it to three dimensions. Both chaotic and regular motion is observed, depending on the objects' initial inclination and phase. For zero inclination, objects that are phase-protected from close encounters with Neptune show ordered motion even at eccentricities as large as 0.4 and despite being Neptune-crossers. On the other hand, not-phase-protected objects with eccentricities greater than 0.15 follow chaotic motion that leads to sudden jumps in their eccentricity and are removed from the 2:3 resonance, thus becoming short period comets. As inclination increases, chaotic motion becomes more widespread, but phase-protection still exists and, as a result, stable motion appears for eccentricities up to $e = 0.3$ and inclinations as high as $i = 15°$, a region where plutinos exist.

Published in: Celestial Mechanics and Dynamical Astronomy, 84, 135 (Oct. 2002)

For preprints, contact `hadjidem@auth.gr`

or on the web at `http://users.auth.gr/~hadjidem/res2-3.pdf`

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Resonant Periodic Orbits of Trans-Neptunian Objects

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We study two and three-dimensional resonant periodic orbits, using the model of the restricted three-body problem with the Sun and Neptune as primaries. The position and the stability character of the periodic orbits determine the structure of the phase space and this will provide useful information on the stability and long term evolution of trans-Neptunian objects. The circular planar model is used as the starting point. Families of periodic orbits are computed at the exterior resonances 1/2, 2/3 and 3/4 with Neptune and these are used as a guide to select the energy levels for the computation of the Poincaré maps, so that all basic resonances are included in the study. Using the circular planar model as the basic model, we extend our study to more realistic models by considering an elliptic orbit of Neptune and introducing the inclination of the orbit. Families of symmetric periodic orbits of the planar elliptic restricted three-body problem and the three-dimensional problem are found. All these orbits bifurcate from the families of periodic orbits of the planar circular problem. The stability of all orbits is studied. Although the resonant structure in the circular problem is similar for all resonances, the situation changes if the eccentricity of Neptune or the inclination of the orbit is taken into account. All these results are combined to explain why in some resonances there are many bodies and other resonances are empty.

To appear in: Earth, Moon and Planets

For preprints, contact `hadjidem@auth.gr`

or on the web at `http://users.auth.gr/~hadjidem/k-h.pdf`

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A New Class of Trans-Neptunian Objects in High-Eccentricity Orbits

V.V. Emel'yanenko[1], D.J. Asher[2], and M.E. Bailey[2]

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A symplectic integrator is used to study the evolution of high-eccentricity trans-Neptunian objects (TNOs) over the age of the Solar system. For 26 objects, a few cloned orbits were integrated. The existence is demonstrated of several known bodies which are in relatively stable orbits located far from Neptune for the age of the Solar system, thus providing an indication of the structure of the protoplanetary disc immediately after the period of planet formation. The orbits of these bodies cannot be explained by a model in which a near-Neptune disc of planetesimals is gravitationally scattered by Neptune. This work therefore demonstrates the existence of a new, and populous, class of 'outer' TNOs which have substantially different dynamical characteristics from those of scattered disc objects.

To appear in: Monthly Notices of the Royal Astronomical Society

Preprints available on the web at `http://star.arm.ac.uk/preprints/`

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Orbit Computation for Transneptunian Objects

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Using statistical orbital ranging, we systematically study the orbit computation problem for transneptunian objects (TNOs). We have automated orbit computation for large numbers of objects, and, more importantly, we are able to obtain orbits even for the most sparsely observed objects (observational arcs of a few days). For such objects, the resulting orbit distributions include a large number of high-eccentricity orbits, in which TNOs can be perturbed by close encounters with Neptune. The stability of bodies on the computed orbits has therefore been ascertained by performing a study of close encounters with the major planets. We classify TNO orbit distributions statistically, and we study the evolution of their ephemeris uncertainties. We find that the orbital element distributions for the most numerous single-apparition TNOs do not support the existence of a postulated sharp edge to the belt beyond 50 AU. The technique of statistical ranging provides ephemeris predictions more generally than hitherto, also for poorly observed TNOs.

To appear in: Icarus

For preprints, contact `jenni.virtanen@astro.helsinki.fi`

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Detection of Two Binary Trans-Neptunian Objects, 1997 CQ_{29} and 2000 CF_{105}, with the Hubble Space Telescope

Keith S. Noll[1], Denise C. Stephens[1], Will M. Grundy[2], Robert L. Millis[2], John Spencer[2], Marc W. Buie[2], Stephen C. Tegler[3], William Romanishin[4], and Dale P. Cruikshank[5]

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Images of the trans-Neptunian objects 1997 CQ_{29} and 2000 CF_{105} obtained with the Hubble Space Telescope's WFPC2 camera show them to be binary. The two components of 1997 CQ_{29} were separated in our images by 0.20±0.03 arsec in November 2001 and by 0.33±0.01 arcsec in June/July 2002. The corresponding minimum physical distances are 6100 km and 10,200 km. The companion to 2000 CF_{105} was 0.78±0.03 arcsec from the primary, at least 23,400 km. Six other objects in the trans-Neptunian region, including Pluto and its moon Charon, are known to be binaries; 1997 CQ_{29} and 2000 CF_{105} are the seventh and eighth known pair. Binarity appears to be a not-uncommon characteristic in this region of the solar system, with detectable companions present in 4±2% of the objects we have examined.

To appear in: The Astronomical Journal

For preprints, contact Keith Noll at: `noll@stsci.edu`

or on the web at `http://arXiv.org/abs/astro-ph/0210593`

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Formation of Kuiper Belt Binaries by Dynamical Friction and Three-Body Encounters in The Early Solar System

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The Kuiper belt is a disk of icy bodies that orbit the Sun beyond Neptune; its largest known members are Pluto and its companion Charon. These bodies grew from smaller ones by accretion. The latest of many surprises is the discovery that a few percent of the large Kuiper Belt objects are in binaries with wide separations and mass ratios of order unity. Collisions were too infrequent to account for the observed binaries, implying that binaries formed by collisionless interactions mediated by gravity. These were most potent during the period of runaway accretion. Here we show that a transient binary forms when two large bodies penetrate each other's Hill spheres (the region wherein the mutual forces are larger than the tidal force of the Sun). The loss of energy needed for stabilization of the binary orbit occurs either through dynamical friction due to small bodies or the scattering of a third large body. Our estimates slightly favor the former mechanism. We predict that $\sim$5% of KBOs are binaries with separations greater than $0.2''$, in agreement with the ongoing HST survey, and that most are in tighter binaries or systems of higher multiplicity.

To appear in: Nature

For preprints, contact `sari@tapir.caltech.edu`

PAPERS RECENTLY SUBMITTED TO JOURNALS

Direct Measurement of the Size of the Large Kuiper Belt Object Quaoar

M.E. Brown[1] and C.A. Trujillo[1]

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

Submitted to: The Astronomical Journal

Preprints on the web at `http://www.gps.caltech.edu/~mbrown/papers/`

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The Dynamics of Known Centaurs

M.S. Tiscareno[1] and R. Malhotra[1]

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Submitted to: The Astronomical Journal

For preprints, contact `matthewt@lpl.arizona.edu`

or on the web at `http://arxiv.org/abs/astro-ph/0211076`

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Kuiper Belt & Solar System Origin

A. Morbidelli[1] and M.E. Brown[2]

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Submitted to: Comets II (Festou et al. eds., University of Arizona Press)

For preprints, contact `morby@obs-nice.fr`

or on the web at `http://www.obs-nice.fr/morby/Invited_list.html` (item # XX)

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Kuiper Belt and Oort Cloud Objects: Microlenses or Stellar Occulters?

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Submitted to: Astronomy and Astrophysics

For preprints, contact `asante@caltech.edu`

or on the web at `http://arXiv.org/abs/astro-ph/0209545`

CONFERENCE CONTRIBUTIONS

Formation and Migration of Trans-Neptunian Objects

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To appear in: the proceedings of "Scientific Frontiers in Research of Extrasolar Planets"

For preprints, contact `siipatov@hotmail.com`

or on the web at `http://arXiv.org/abs/astro-ph/0210131`

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Periodic Orbits of Trans-Neptunian Objects at the 2/3 and 3/4 Resonances

Thomas A. Kotoulas[1] **and John D. Hadjidemetriou**[1]

[1] Department of Physics, University of Thessaloniki, 541 24 Thessaloniki, Greece

To appear in: Celestial Mechanics and Dynamical Astronomy

(in the proceedings of the CELMEC III Meeting on Celestial Mechanics)

For preprints, contact `hadjidem@auth.gr`

or on the web at `http://users.auth.gr/~hadjidem/kot-hadj.pdf`

CONFERENCE INFORMATION

First Decadal Review of the Edgeworth-Kuiper-Belt: Towards New Frontiers

2003 March 3–7

Universidad Católica del Norte, Antofagasta, Chile

`http://tno.ucn.cl/`

This workshop present and review the scientific knowledge on the Edgeworth-Kuiper-Belt and related objects with the aim to define the new frontiers of research to be addressed critically in the future. Review talks and contributed papers (oral and posters if needed) will be organized around the following topics:

- The dynamical picture of the outer solar system
- The taxonomic populations (KBOs, Centaurs, satellites, comets)
- The formation, evolution and links between dynamical and physical aspects
- The modelling concepts and physical interpretations
- The impact of laboratory studies
- Mission targets: Pluto/Charon and the New Horizons mission, cometary missions
- The observational, modelling and experimental challenges (methods and key programs)
- The synoptic view of the outer solar system and bodies therein
- "Edgeworth-Kuiper-Belts" around the Sun and other Stars

If you wish to receive an invitation to the Workshop please contact Dr. Luis Barrera at: `lbarrera@ucn.cl`

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`