Issue No. 25 *September 2002*

DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

The National Research Council recently released the Solar System Exploration Decadal Survey "New Frontiers in the Solar System: An Integrated Exploration Strategy". The Survey reviews the current state of planetary science and exploration, and makes recommendations for investments in ground-based and space flight research for the next decade, 2003-2013. The Kuiper belt figures prominently throughout the report. Of particular interest to readers of this newsletter is the Survey's very strong support for a Kuiper Belt-Pluto Explorer mission, which is given the highest priority recommendation for its class (medium cost Solar System Flight Missions). The report also recommends support for ground-based telescope projects, such as the Large-aperture Synoptic Survey Telescope (LSST) and the Giant Segmented Mirror Telescope (GSMT), explicitly including Kuiper belt studies as a major science driver. The report can be ordered at `http://www.nationalacademies.org/ssb/` and the full text of the report can be obtained in three PDF files at `http://www.aas.org/~dps/decadal/`

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The "Pluto Portal" is now available at: `http://www.boulder.swri.edu/plutoportal/`

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And yet more Pluto news: the Pluto occultation observing campaign was successful in making detections during the July 20 and August 21 events. Preliminary results show that Pluto's atmosphere is cooling and going though other global changes. See:
`http://www.spaceref.com/news/viewpr.html?pid=9033`
`http://www.eso.org/outreach/press-rel/pr-2002/phot-21-02.html`
`http://despa.obspm.fr/~sicardy/pluton/results.html`

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Followup HST observations by Noll et al. have confirmed that 1997 CQ29 is, indeed, a binary. Original images on the WF3 CCD, only showed possible elongation of the object; these new observations with the PC CCD clearly resolve the components, which have a separation of 0.33 arcsec and confirmed binary motion.
IAUC 7959: `http://cfa-www.harvard.edu/iauc/07900/07959.html`
Similarly, Keck observations by Romanishin et al. confirm the binarity of 2000 CF105:
IAUC 7962: `http://cfa-www.harvard.edu/iauc/07900/07962.html`

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There were 3 new TNO discoveries announced since the last issue of the *Distant EKOs* Newsletter:
    2002 AW197, 2002 KW14, 2002 KX14
and 3 new Centaur/SDO discoveries.
    2002 KY14, 2002 JR146, 2002 PN34

Reclassified objects:
2002 GP32 (TNO $\rightarrow$ SDO)
1999 CG119 (TNO $\rightarrow$ SDO)

Objects recently assigned numbers:
1999 OX3 = (44594)
2000 PV29 = (45802)

Objects recently assigned names:
1999 HX11 = Rhadamanthus

Current number of TNOs: 563 (and Pluto & Charon, and 7 other TNO binary companions)
Current number of Centaurs/SDOs: 120

PAPERS ACCEPTED TO JOURNALS

Observational Limits on a Distant Cold Kuiper Belt

R.L. Allen[1], G.M. Bernstein[1], and R. Malhotra[2]

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Almost all of the >500 known Kuiper belt objects (KBOs) have been discovered within 50 AU of the Sun. One possible explanation for the observed lack of KBOs beyond 50 AU is that the distant Kuiper belt is dynamically very cold, and thus thin enough on the sky to have slipped between previous deep survey fields. We have completed a survey designed to search for a dynamically cold distant Kuiper belt near the invariable plane of the Solar system. In 2.3 deg^2 we have discovered a total of 33 KBOs and 1 Centaur, but no objects in circular orbits beyond 50 AU. We find that we can exclude at 95% CL the existence of a distant disk inclined by $i \leq 1°$ to the invariable plane and containing more than 1.2 times as many $D > 185$ km KBOs between 50 and 60 AU as the observed inner Kuiper belt, if the distant disk is thinner than $\sigma = 1.75°$.

To appear in: The Astronomical Journal

For preprints, contact `rhiannon@astro.lsa.umich.edu`

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Planetary Perturbations on the 2:3 Mean Motion Resonance with Neptune

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A mean motion resonance with Neptune is one of the major dynamical characteristics of the Edgeworth-Kuiper Belt Objects that spread over the outside of Neptune's orbit. We investigated the influence of Jupiter, Saturn, and Uranus on the dynamical structure of the 2:3 mean motion resonance with Neptune. Since the distance between the planets and objects has great influence on the dynamical structure, numerical integrations were carried out for test particles for 5 Myr under five fictitious solar-system models having different configurations. In discussion about the results, we concentrate on the size of the EKBO eccentricities, e, because they have an especially close relation to the orbital evolution; for example, larger e objects have more opportunities to encounter other objects or planets. By comparing the results of each model, it was found that the resonance structure is not largely affected by Jupiter and Saturn, and that the largest e of the resonant objects depends on the distance between Uranus and the resonance. The distance also influences the structure around the resonance because of variation in the secular resonance positions. We further found that the largest e values of the non-resonant objects at each semi-major axis do not depend on the distance from Uranus; however, they depend on the distance from Neptune.

Published in: Publications of the Astronomical Society of Japan, 54, 493 (2002 June)

For reprints, contact `tetsu@subaru.naoj.org`

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On the Plutinos and Twotinos of the Kuiper Belt

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We illuminate dynamical properties of Kuiper Belt Objects (KBOs) in the 3:2 ("Plutino") and 2:1 ("Twotino") Neptunian resonances within the model of resonant capture and migration. We analyze a series of numerical integrations, each involving the 4 migratory giant planets and 400 test particles distributed throughout trans-Neptunian space, to measure the efficiencies of capture into the 3:2 and 2:1 resonances, the efficiencies of capture into Kozai-type secular resonances, and the libration centers and amplitudes of resonant particles, all as functions of the migration speed. We synthesize instantaneous snapshots of the spatial distribution of $\sim 10^4$ resonant KBOs, from which we derive the longitudinal variation of the sky density of each resonant family. Twotinos cluster $\pm 75^\circ$ away from Neptune's longitude, while Plutinos cluster $\pm 90^\circ$ away. Such longitudinal clustering persists even for surveys that are not volume-limited in their ability to detect resonant KBOs. Remarkably, between -90° and -60° of Neptune's longitude, we find the ratio of sky densities of Twotinos to Plutinos to be nearly unity despite the greater average distance of Twotinos, assuming the two resonant populations are equal in number and share the same size, albedo, and inclination distributions. We couple our findings to observations to crudely estimate that Plutinos intrinsically outnumber Twotinos by a factor not exceeding ~ 3. Most strikingly, the migration model predicts an asymmetry in the spatial distribution of Twotinos: more Twotinos are expected to lie at longitudes behind that of Neptune than ahead of it. The magnitude of the asymmetry amplifies dramatically with faster rates of migration and can be as large as $\sim 300\%$. A differential measurement of the sky density of 2:1 resonant objects behind of and in front of Neptune's longitude would powerfully constrain the migration history of that planet.

To appear in: The Astronomical Journal

For preprints, contact `echiang@astron.berkeley.edu`

or on the web at `http://astron.berkeley.edu/~echiang/ppp/ppp.html`

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A Study of the Dynamics of Dust from the Kuiper Belt: Spatial Distribution and Spectral Energy Distribution

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The dust produced in the Kuiper Belt (KB) spreads throughout the Solar System forming a dust disk. We numerically model the orbital evolution of KB dust and estimate its equilibrium spatial distribution and its brightness and spectral energy distributions (SED), assuming greybody absorption and emission by the dust grains. We show that the planets modify the KB disk SED, so potentially we can infer the presence of planets in spatially unresolved debris disks by studying the shape of their SEDs. We point out that there are inherent uncertainties in the prediction of structure in the dust disk, owing to the chaotic dynamics of dust orbital evolution imposed by resonant gravitational perturbations of the planets.

To appear in: The Astronomical Journal

For preprints, contact `amaya@as.arizona.edu`

or on the web at `http://www.lpl.arizona.edu/people/faculty/malhotra2.html`

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Long-term Evolution of Objects in the Kuiper Belt Zone — Effects of Insolation and Radiogenic Heating

Young-Jun Choi[1], Merav Cohen[1], Rainer Merk[1], and Dina Prialnik[1]

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The Kuiper Belt zone is unique insofar as the major heat sources of objects a few tens of kilometers in size — solar radiation on the one hand, and radioactive decay on the other — have comparable power. This leads to unique evolutionary patterns, with heat waves propagating inward from the irradiated surface and outwards from the radioactively heated interior. A major radioactive source that is considered in this study is ^{26}Al. The long-term evolution of several models with characteristics typical of Kuiper Belt objects is followed by means of a 1-D numerical code that solves the heat and mass balance equations on a spherically symmetric grid. The free parameters considered are radius (10–500 km), heliocentric distance (30–120 AU), and initial ^{26}Al content (0–5×10^{-8} by mass). The initial composition assumed is a porous mixture of ices (H_2O, CO, and CO_2) and dust. Gases released in the interior are allowed to escape to the surface. It is shown that, depending on parameters, the interior may reach quite high temperatures (up to 180 K). The models suggest that Kuiper Belt objects are likely to lose the ices of very volatile species during early evolution; ices of less volatile species are retained in a surface layer, about 1 km thick. The models indicate that the amorphous ice crystallizes in the interior, and hence some objects may also lose part of the volatiles trapped in amorphous ice. Generally, the outer layers are far less affected than the inner part, resulting in a stratified composition and altered porosity distribution. These changes in structure and composition should have significant consequences for the short-period comets, which are believed to be descendants of Kuiper Belt objects.

To appear in: Icarus
For preprints, contact `dina@planet.tau.ac.il`

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Observations of the Centaur 1999 UG_5: Evidence of a Unique Outer Solar System Surface

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[2] University of Texas, Dept. of Astronomy, Austin, TX 78712, USA

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The outer Solar system body 1999 UG_5 is a Centaur of medium brightness and slightly redder color when compared to other Centaurs. Similar to at least one fifth of the known Centaurs, it is a Saturn-crosser with a mean orbital distance between Saturn and Uranus. We present optical photometry data and NIR spectra obtained during September, November, and December, 2000. We find a rotation period of 13.41 ± 0.04 hours with an amplitude of 0.102 ± 0.005 mag, and a phase curve with a Lumme-Bowell G value of -0.13 ± 0.02. $BVRI$ colors are reported, and confirm the red spectral gradient observed previously. Our spectra reveal that this redward slope extends into NIR wavelengths and indicate possible localized differences in the surface composition.

To appear in: Publications of the Astronomical Society of the Pacific
For preprints, contact `bauer@ifa.hawaii.edu`

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Photometric Light Curve for the Kuiper Belt Object 2000 EB173 on 78 Nights

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Kuiper Belt Objects (KBOs) are generally very faint and cannot in practice be monitored with a well-sampled long-term light curve; so our discovery of the bright KBO 2000 EB_{173} offers an excellent opportunity for synoptic studies. We present a well-sampled photometric time series (77 R magnitudes and 29 V magnitudes on 78 nights) over a 225-day time span centered on the 2001 opposition. The light curve (corrected to the year 2001 opposition distance) varies from 19.11 to 19.39 mag with a single peak that is smooth, time symmetric, and coincident with opposition. All variations in the light curve are consistent with a linear opposition surge ($R_{OPP} = 19.083 + 0.125\alpha$, where α is the solar phase angle), while any rotational modulation must have a peak-to-peak amplitude of less than 0.097 mag. This is the first measured opposition surge for any KBO (other than Pluto). The $V - R$ color is 0.63 ± 0.02, with no apparent variation with phase at the few percent level. With $R = 19.11$ at opposition, 2000 EB_{173} remains the brightest known KBO and a prime target for future photometric and spectroscopic studies.

To appear in: Icarus

For preprints, contact `schaefer@astro.as.utexas.edu`

or on the web at `http://arXiv.org/abs/astro-ph/0208261`

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On the Detectability of Lightcurves of Kuiper Belt Objects

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We present a statistical study of the detectability of lightcurves of Kuiper Belt objects (KBOs). Some Kuiper Belt objects display lightcurves that appear "flat", i.e., there are no significant brightness variations within the photometric uncertainties. Under the assumption that KBO lightcurves are mainly due to shape, the lack of brightness variations may be due to (1) the objects have very nearly spherical shapes, or (2) their rotation axes coincide with the line of sight. We investigate the relative importance of these two effects and relate it to the observed fraction of "flat" lightcurves. This study suggests that the fraction of KBOs with detectable brightness variations may provide clues about the shape distribution of these objects. Although the current database of rotational properties of KBOs is still insufficient to draw any statistically meaningful conclusions, we expect that, with a larger dataset, this method will provide a useful test for candidate KBO shape distributions.

To appear in: Icarus

For preprints, contact `placerda@strw.leidenuniv.nl`

PAPERS RECENTLY SUBMITTED TO JOURNALS

Formation of Kuiper Belt Binaries

Peter Goldreich[1], Yoram Lithwick[1], and Re'em Sari[1]

[1] Theoretical Astrophysics, Caltech 130-33, Pasadena, CA 91125 USA

Submitted to: Nature

For preprints, contact yoram@tapir.caltech.edu

or on the web at http://arXiv.org/abs/astro-ph/0208490

OTHER PAPERS OF INTEREST

Out on The Edge

W.B. McKinnon[1]

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Published in: Nature, 418, 135 (2002)

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Focus on Education: Striking Kuiper Belt Gold

Jodi Asbell-Clarke[1]

[1] TERC, 2067 Massachusetts Avenue, Cambridge, MA 02140, USA

Published in: Mercury, 31, 13 (2002)

For preprints, contact Jodi_Asbell-Clarke@terc.edu

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Dusty Rings: Signposts of Recent Planet Formation

Scott J. Kenyon[1] and Benjamin C. Bromley[2]

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[2] Department of Physics, University of Utah, 201 JFB, Salt Lake City, UT 84112, USA

To appear in: The Astrophysical Journal Letters

For preprints, contact skenyon@cfa.harvard.edu

or on the web at http://arXiv.org/abs/astro-ph/0208155

CONFERENCE CONTRIBUTIONS

On the Initial Thermal Evolution of Kuiper Belt Objects

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To appear in: Proceedings of Asteroids, Comets, Meteors 2002

For preprints, contact mckinnon@levee.wustl.edu

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The above submission reminded me that abstracts of ACM presentations are available at:
`http://berlinadmin.dlr.de/SGF/acm2002/Abstractweblist-020618-Session.html`

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The DPS meeting will be held in Birmingham, Alabama, USA on October 6–11
Details are available at: `http://csem.engin.umich.edu/dps/`
The meeting program shows the following Kuiper belt related sessions:

- Monday, October 8
  - Session 7. **Centaurs and Kuiper Belt Objects I**
    Oral, 14:30–15:30 and 16:00–16:30, Ballroom
    `http://www.aas.org/publications/baas/v34n3/dps2002/S70.htm`
  - Session 9. **Centaurs and Kuiper Belt Objects II**
    Oral, 16:00–17:30, Ballroom
    `http://www.aas.org/publications/baas/v34n3/dps2002/S90.htm`
- Tuesday, October 9
  - Session 17. **Centaurs and Kuiper Belt**
    Poster, 15:30–18:00, Exhibit Hall
    `http://www.aas.org/publications/baas/v34n3/dps2002/S170.htm`
- Wednesday, October 10
  - Session 20. **Pluto Occultations 2002**
    Invited, 8:30–9:15, Ballroom
    `http://www.aas.org/publications/baas/v34n3/dps2002/S200.htm`
  - Session 21. **Pluto, Charon and Triton**
    Oral, 9:20–10:10, Ballroom
    `http://www.aas.org/publications/baas/v34n3/dps2002/S210.htm`
- Thursday, October 11
  - Session 26. **Decadal Study**
    Special, 10:30–12:30, Ballroom
    `http://www.aas.org/publications/baas/v34n3/dps2002/S260.htm`
  - Session 28. **Solar System Origin, Planet and Satellite Formation**
    Oral, 14:00–16:00, Room M
    `http://www.aas.org/publications/baas/v34n3/dps2002/S280.htm`
  - Session 29. **Solar System Origin, Planet and Satellite Formation**
    Poster, 16:00–18:30, Exhibit Hall
    `http://www.aas.org/publications/baas/v34n3/dps2002/S290.htm`

BOOKS

Modern Celestial Mechanics: Aspects of Solar System Dynamics

A. Morbidelli[1]

[1] Observatoire de la Côte d'Azur, B.P. 4229, 06304 Nice Cedex 4, France

In the last 20 years celestial mechanics has achieved spectacular results on the structure and evolution of our solar system. With a solid theoretical basis this book describes recent results on solar system dynamics, with emphasis on planets and small bodies. It begins by presenting the fundamental concepts of Hamiltonian systems theory, necessary to work at ease in celestial mechanics. Celestial mechanics itself is then considered, including the secular motion of planets and small bodies and mean motion resonant dynamics. *Modern Celestial Mechanics* will be of interest to graduate students and researchers of astronomy and astrophysics.

Contents

Published in: Advances in Astronomy and Astrophysics, Volume 5
(ed. Taylor & Francis; London and New York)

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Available for purchase on the web at `http://www.tandf.co.uk/`

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`