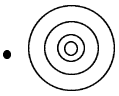
Issue No. 31 *September 2003*

DISTANT EKOs



The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

Two new sky surveys with TNO search components have begun recently at Palomar and CFHT observatories. Both are using large field-of-view CCD mosaic arrays, at a few hundred million pixels per image! Time to buy more disk space...
CFHTLS: `http://www.cfht.hawaii.edu/Science/CFHLS/`
QUEST: `http://pr.caltech.edu/media/Press_Releases/PR12417.html`

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There were 47 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2003 GF55, 2003 KO20, 2003 KP20, 2003 LA7, 2003 LB7, 2003 LC7, 2003 LD7, 2003 LE7, 2003 LF7, 2003 LG7, 2003 LZ6, 2003 BF91, 2003 BG91, 2003 BH91, 2003 LD9, 2003 QA91, 2003 QA92, 2003 QB91, 2003 QB92, 2003 QC91, 2003 QD91, 2003 QE91, 2003 QF91, 2003 QG91, 2003 QH91, 2003 QJ91, 2003 QK91, 2003 QL91, 2003 QM91, 2003 QN91, 2003 QO91, 2003 QP91, 2003 QQ91, 2003 QR91, 2003 QS91, 2003 QT90, 2003 QT91, 2003 QU90, 2003 QU91, 2003 QV90, 2003 QV91, 2003 QW90, 2003 QW91, 2003 QX90, 2003 QX91, 2003 QY90, 2003 QZ90

and 4 new Centaur/SDO discoveries:

2003 KQ20, 2003 LH7, 2003 QY91, 2003 QZ91

Reclassified objects:

2002 GX32 (TNO → SDO)
2000 PL30 (SDO → TNO)

Re-identified objects:

1996 KW1 = 2001 KO76

Current number of TNOs: 722 (and Pluto & Charon, and 9 other TNO binary companions)
Current number of Centaurs/SDOs: 132
Current number of Neptune Trojans: 1

Out of a total of 855 objects:

426 have measurements from only one opposition
309 of those have had no measurements for more than a year
176 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

Reopening the TNOs Color Controversy: Centaurs Bimodality and TNOs Unimodality

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We revisit the Trans-Neptunian Objects (TNOs) color controversy allegedly solved by Teggler & Romanishin (2003). We debate the statistical approach of the quoted work and discuss why it can not draw the claimed conclusions, and reanalyze their data sample with a more adequate statistical test. We find evidence for the existence of two color groups among the Centaurs. Therefore, mixing both centaurs and TNOs populations lead to the erroneous conclusion of a global bimodality, while there is no evidence for two color groups in the TNOs population alone. We use quasi-simultaneous visible color measurements published for 20 centaurs (corresponding to about half of the identified objects of this class), and conclude on the existence of two groups. With the surface evolution model of Delsanti et al. (2003) we discuss how the existence of two groups of Centaurs may be compatible with a continuous TNOs color distribution.

To appear in: Astronomy & Astrophysics
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A Study of Short Term Rotational Variability in TNOs and Centaurs from Sierra Nevada Observatory

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Broad band CCD observations focused on short-term rotational variability have been carried out for six TNOs; 1999 TD_{10}, 1999 TC_{36}, 2000 EB_{173}, (20000) Varuna, (28978) Ixion, 2002 CR_{46}, and four Centaurs; 2000 QC_{243}, 2001 PT_{13}, 2002 PN_{34} and 2002 GO_9 using the 1.5m telescope at Sierra Nevada Observatory (Granada, Spain) since mid 2001. Three of the bodies exhibit periodic double-peaked lightcurves with amplitudes larger than 0.4 mag while another four show periodic variability with amplitudes below 0.20 mag. Basic physical properties of these objects can be derived or constrained from the observations. Here we present a summary of the main results obtained for these objects.

Published in: Astronomy & Astrophysics, 407, 1149 (2003 September)
For preprints, contact ortiz@iaa.es

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Rotational Brightness Variations in Trans-Neptunian Object 50000 Quaoar

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Time-resolved broad-band CCD photometry of Trans-Neptunian Object 50000 Quaoar carried out using the 1.5m telescope at Sierra Nevada Observatory is presented. The lightcurve reveals short-term variability due to rotation of the body. The periodogram analysis shows a peak at 8.8394±0.0002 h with a confidence level above 99.9%. The lightcurve seems to be double-peaked, and therefore the rotation period would be 17.6788±0.0004 h. The amplitude of the oscillation is 0.133±0.028 mag. Under the assumption that the rotational variation is induced by an irregular shape, the minimum axial ratio of Quaoar would then be 1.133±0.028.

To appear in: Astronomy and Astrophysics
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Resonant and Secular Families of the Kuiper Belt

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[3] Institute for Astronomy at Hawaii, USA

We review ongoing efforts to identify occupants of mean-motion resonances (MMRs) and collisional families in the Edgeworth-Kuiper belt. Direct integrations of trajectories of Kuiper belt objects (KBOs) reveal the 1:1 (Trojan), 5:4, 4:3, 3:2 (Plutino), 5:3, 7:4, 9:5, 2:1 (Twotino), and 5:2 MMRs to be inhabited. Apart from the Trojan, resonant KBOs typically have large orbital eccentricities and inclinations. The observed pattern of resonance occupation is consistent with resonant capture and adiabatic excitation by a migratory Neptune; however, the dynamically cold initial conditions prior to resonance sweeping that are typically assumed by migration simulations are probably inadequate. Given the dynamically hot residents of the 5:2 MMR and the substantial inclinations observed in all exterior MMRs, a fraction of the primordial belt was likely dynamically pre-heated prior to resonance sweeping. A pre-heated population may have arisen as Neptune gravitationally scattered objects into trans-Neptunian space. The spatial distribution of Twotinos offers a unique diagnostic of Neptune's migration history. The Neptunian Trojan population may rival the Jovian Trojan population, and the former's existence is argued to rule out violent orbital histories for Neptune. Finally, lowest-order secular theory is applied to several hundred non-resonant KBOs with well-measured orbits to update proposals of collisional families. No convincing family is detected.

To appear in: Earth, Moon, and Planets (special issue, as part of First Decadal Review of the Edgeworth-Kuiper Belt)
For preprints, contact `echiang@astron.berkeley.edu`
or on the web at `http://astron.berkeley.edu/~echiang/ppp/ppp.html`

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The Populations of Comet-like Bodies in the Solar System

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A new classification scheme is introduced for comet-like bodies in the Solar system. It covers the traditional comets as well as the Centaurs and Edgeworth-Kuiper belt objects. At low inclinations, close encounters with planets often result in near-constant perihelion or aphelion distances, or in perihelion-aphelion interchanges, so the minor bodies can be labelled according to the planets predominantly controlling them at perihelion and aphelion. For example, a JN object has a perihelion under the control of Jupiter and aphelion under the control of Neptune, and so on. This provides 20 dynamically distinct categories of outer Solar System objects in the Jovian and trans-Jovian regions. The Tisserand parameter with respect to the planet controlling perihelion is also often roughly constant under orbital evolution. So, each category can be further subdivided according to the Tisserand parameter.

The dynamical evolution of comets, however, is dominated not by the planets nearest at perihelion or aphelion, but by the more massive Jupiter. The comets are separated into four categories — Encke-type, short-period, intermediate and long-period — according to aphelion distance. The Tisserand parameter categories now roughly correspond to the well-known Jupiter-family comets, transition types and Halley types. In this way, the nomenclature for the Centaurs and Edgeworth-Kuiper belt objects is based on, and consistent with, that for comets. Given the perihelion and aphelion distances together with the Tisserand parameter, our classification scheme provides a description for any comet-like body in the Solar system. The usefulness of the scheme is illustrated with examples drawn from numerical simulations and from the present-day Solar system.

Published in: Monthly Notices of the Royal Astronomical Society, 343, 1057

For preprints, contact `nwe@thphys.ox.ac.uk`

or on the web at `http://hermes.physics.ox.ac.uk/users/JontiHorner/papers.html`

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The Evolution of Comets in the Oort Cloud and Kuiper Belt

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Comets are remnants from the time when the outer planets formed, ∼4–4.5 billion years ago. They have been in storage since then in the Oort cloud and Kuiper belt—distant regions that are so cold and sparsely populated that it was long thought that comets approaching the Sun were pristine samples from the time of Solar System formation. It is now recognized, however, that a variety of subtle but important evolutionary mechanisms operate on comets during their long storage, so they can no longer be regarded as wholly pristine.

Published in: Nature, 424, 639 (2003 Aug 07)

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Migration of Trans-Neptunian Objects to the Terrestrial Planets

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The orbital evolution of more than 22,000 Jupiter-crossing objects under the gravitational influence of planets was investigated. We found that the mean collision probabilities of Jupiter-crossing objects (from initial orbits close to the orbit of a comet) with the terrestrial planets can differ by more than two orders of magnitude for different comets. For initial orbital elements close to those of some comets (e.g. 2P and 10P), about 0.1% of objects got Earth-crossing orbits with semi-major axes $a < 2$ AU and moved in such orbits for more than a Myr (up to tens or even hundreds of Myrs). Results of our runs testify in favor of at least one of these conclusions: 1) the portion of 1-km former trans-Neptunian objects (TNOs) among near-Earth objects (NEOs) can exceed several tens of percents, 2) the number of TNOs migrating inside solar system could be smaller by a factor of several than it was earlier considered, 3) most of 1 km former TNOs that had got NEO orbits disintegrated into mini-comets and dust during a smaller part of their dynamical lifetimes if these lifetimes are not small.

To appear in: Earth, Moon, and Planets

For preprints, contact sipatov@gmu.edu

or on the web at http://arXiv.org/abs/astro-ph/0305519

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Comet and Asteroid Hazard to the Terrestrial Planets

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[2] Institute of Applied Mathematics, Miusskaya sq. 4, Moscow 125047, Russia

We estimated the rate of comet and asteroid collisions with the terrestrial planets by calculating the orbits of 13,000 Jupiter-crossing objects (JCOs) and 1,300 resonant asteroids and computing the probabilities of collisions based on random-phase approximations and the orbital elements sampled with a 500 yr step. The Bulirsh-Stoer and a symplectic orbit integrator gave similar results for orbital evolution, but may give different collision probabilities with the Sun. A small fraction of former JCOs reached orbits with aphelia inside Jupiter's orbit, and some reached Apollo orbits with semi-major axes less than 2 AU, Aten orbits, and inner-Earth orbits (with aphelia less than 0.983 AU) and remained there for millions of years. Though less than 0.1% of the total, these objects were responsible for most of the collision probability of former JCOs with Earth and Venus. We conclude that a significant fraction of near-Earth objects could be extinct comets that came from the trans-Neptunian region.

To appear in: Advances in Space Research

For preprints, contact sipatov@gmu.edu

or on the web at http://arXiv.org/abs/astro-ph/0212177

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The Recent Expansion of Pluto's Atmosphere

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Stellar occultations-the passing of a relatively nearby body in front of a background star-can be used to probe the atmosphere of the closer body with a spatial resolution of a few kilometres. Such observations can yield the scale height, temperature profile, and other information about the structure of the occulting atmosphere. Occultation data acquired for Pluto's atmosphere in 1988 revealed a nearly isothermal atmosphere above a radius of ~1,215 km. Below this level, the data could be interpreted as indicating either an extinction layer or the onset of a large thermal gradient, calling into question the fundamental structure of this atmosphere. Another question is to what extent Pluto's atmosphere might be collapsing as it recedes from the Sun (passing perihelion in 1989 in its 248-year orbital period), owing to the extreme sensitivity of the equilibrium surface pressure to the surface temperature. Here we report observations at a variety of visible and infrared wavelengths of an occultation of a star by Pluto in August 2002. These data reveal evidence for extinction in Pluto's atmosphere and show that it has indeed changed, having expanded rather than collapsed, since 1988.

Published in: Nature, 424, 165 (2003 July 10)
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Large Changes in Pluto's Atmosphere as Revealed by Recent Stellar Occultations

B. Sicardy[1] **et al.**

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Pluto's tenuous nitrogen atmosphere was first detected by the imprint left on the light curve of a star that was occulted by the planet in 1985, and studied more extensively during a second occultation event in 1988. These events are, however, quite rare and Pluto's atmosphere remains poorly understood, as in particular the planet has not yet been visited by a spacecraft. Here we report data from the first occultations by Pluto since 1988. We find that, during the intervening 14 years, there seems to have been a doubling of the atmospheric pressure, a probable seasonal effect on Pluto.

Published in: Nature, 424, 168 (2003 July 10)
For correspondence, contact `bruno.sicardy@obspm.fr`

PAPERS RECENTLY SUBMITTED TO JOURNALS

The Size Distribution of Trans-Neptunian Bodies

G.M. Bernstein[1], D.E. Trilling[1], R.L. Allen[2], M.E. Brown[3], M. Holman[4], and R. Malhotra[5]

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Submitted to: The Astronomical Journal

Preprints, available on the web at:

`http://www.physics.upenn.edu/~garyb/PUBLICATIONS/acs.ps.gz`

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Migration of Interplanetary Dust

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[4] University of Maryland, College Park, MD 20742, USA

Submitted to: Annals of the New York Academy of Sciences

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OTHER PAPERS OF INTEREST

Particle Pile-ups and Planetesimal Formation

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To appear in: The Astrophysical Journal

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

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Pluto's Atmospheric Surprise

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Published in: Nature, 424, 137 (2003 July 10)

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Hydrogen Spectra, Molecular Association and Orbital Radii in the Solar System

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or on the web at http://www.arxiv.org/abs/astro-ph/0307421

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Crazy Names: The Solar System's Nomenclature Wars

R.R. Britt[1]

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Published in: space.com (2003 August 12)

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or on the web at http://www.space.com/scienceastronomy/names_game_030812.html

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CONFERENCE CONTRIBUTIONS

Migration of Jupiter-family Comets and Resonant Asteroids to Near-Earth Space

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[1] NASA/GSFC, Mail Code 685, Greenbelt, MD 20771, USA

[2] Institute of Applied Mathematics, Miusskaya sq. 4, Moscow 125047, Russia

To appear in: proceedings of "New Trends in Astrodynamics and Applications"

For preprints, contact sipatov@gmu.edu

or on the web at http://arXiv.org/abs/astro-ph/0303219

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`