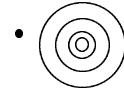


*Issue No. 28*

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*DISTANT EKOs*  
*The Kuiper Belt Electronic Newsletter*



*Edited by: Joel Wm. Parker*

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`www.boulder.swri.edu/ekonews`

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## NEWS & ANNOUNCEMENTS

The discovery that 2001 QR322 is a Neptune trojan was announced by the Deep Ecliptic Survey team in IAUC 8044. As reported in the circular, “this object is the first known Neptune ‘Trojan’ object, being a 1:1 Neptune libration that remains more than 20 AU from Neptune over 14000 yr.” For more information see:

Press release: <http://www.lowell.edu/Press/20030108.html>

IAUC: <http://cfa-www.harvard.edu/iauc/08000/08044.html>

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“Reports of my death are greatly exaggerated.” — Mark Twain

In Greek mythology, Pluto is the lord of Hades, so it is appropriate that a mission to Pluto may be considered one of the undead. After 13+ years of Pluto missions going through on-again/off-again funding and cancellation, the mission *New Horizons* has officially secured funding to put it on line for a launch in 2006 and arrival at Pluto in 2015. See details at:

[http://space.com/scienceastronomy/pluto\\_horizons\\_030225.html](http://space.com/scienceastronomy/pluto_horizons_030225.html)

New Horizons mission websites:

<http://pluto.jhuapl.edu/>

<http://www.boulder.swri.edu/pkb/>

And if you have never heard the story of Pluto put to music, check out the Christine Lavin song “Planet X” at: <http://www.christinelavin.com/022200planetx.html>

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Virtanen and collaborators offer a new online TNO ephemeris predictor (TNOEPH) at

<http://asteroid.lowell.edu/cgi-bin/virtanen/tnoeph>

and also can be accessed via Lowell Observatory’s general page for asteroid observing services:

<http://asteroid.lowell.edu/>

The purpose of this service is to offer the user the means to compute sky-plane uncertainty maps for TNOs with short observational arcs, which will help observers to plan follow-up or recovery observations. TNOEPH is based on the new orbit computation method of statistical orbital ranging (Virtanen et al. 2001, Icarus 153, 412; Virtanen et al. 2003, Icarus, in press), which constitutes a completely general approach to orbit estimation that is particularly applicable to short observational and orbital arcs. The results from TNOEPH include: finder charts, orbital element distributions, and classification of orbit type (classical belt, plutinos, scattered belt, etc.)

For more information contact Jenni Virtanen: [jenni.virtanen@helsinki.fi](mailto:jenni.virtanen@helsinki.fi)

Jenni Virtanen, Mikael Granvik, Karri Muinonen (Observatory, University of Helsinki)

Edward Bowell, Bruce Koehn (Lowell Observatory)

Gonzalo Tancredi (University of Montevideo)

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As a new addition to the newsletter, in the following section that lists the tally of the currently known objects, I now also include some statistics on the extent of the recovery observations. This gives an idea of the number of reasonably “secure” and potentially “lost” objects, though for more specifics one must look at the uncertainties in the orbital elements as helpfully provided by other pages, e.g.:

<http://www.lowell.edu/users/buie/kbo/kbofollowup.html>

<http://cfa-www.harvard.edu/iau/TNO/LastObsTNO.html> (for currently-observable objects)

<http://cfa-www.harvard.edu/iau/MPEph/MPEph.html> (any objects; can also list residuals)

The MPC pages give uncertainties only for objects with multi-opposition measurements.

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More on recoveries, or more accurately, *pre*recoveries. Note that several objects listed below now have been assigned numbers, and many of them were discovered only last year! This is due to the detective work of finding pre-discovery images on old survey plates.  
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There were 12 new TNO discoveries announced since the previous issue of the *Distant EKOs* Newsletter:

2003 AZ84, 2001 QF331, 2002 PD155, 2000 QJ252, 2000 QK252, 2000 QL252,  
2000 QM252, 2000 QN252, 2000 QO252, 2001 QG331, 2001 RL155, 2002 PE155

and no new Centaur/SDO discoveries.

Reclassified objects:

2001 YH140 (SDO → TNO)  
2002 GA32 (TNO → SDO)  
2001 KO77 (SDO → TNO)

Objects recently assigned numbers:

1998 HM151 = (52747)  
1998 SG35 = (52872)  
1998 TF35 = (52975)  
1999 HU11 = (53311)  
2000 PJ30 = (54520)  
2000 QC243 = (54598)  
2002 AW197 = (55565)  
2002 GB10 = (55576)  
2002 TX300 = (55636)  
2002 UX25 = (55637)  
2002 VE95 = (55638)

Deleted/Re-identified objects:

2001 QR322 (removed from list after identification as Neptune trojan)

Current number of TNOs: 664 (and Pluto & Charon, and 8 other TNO binary companions)

Current number of Centaurs/SDOs: 125

Out of a total of 789 objects:

402 have measurements from only one opposition

245 of those have had no measurements for more than a year

131 of those have arcs shorter than 10 days

(for more details, see: [http://www.boulder.swri.edu/ekonews/objects/recov\\_stats.gif](http://www.boulder.swri.edu/ekonews/objects/recov_stats.gif))

## Searching for Water Ice on (47171) 1999 TC36, 1998 SG35, and 2000 QC243: ESO Large Program on TNOs and Centaurs

**E. Dotto<sup>1</sup>, M.A. Barucci<sup>2</sup>, H. Boehnhardt<sup>3</sup>, J. Romon<sup>2</sup>, A. Doressoundiram<sup>2</sup>,  
N. Peixinho<sup>4</sup>, C. de Bergh<sup>2</sup>, and M. Lazzarin<sup>5</sup>**

<sup>1</sup> INAF – Osservatorio Astronomico di Roma, Italy; INAF – Osservatorio Astronomico di Torino, Italy

<sup>2</sup> LESIA – Observatoire de Paris, France

<sup>3</sup> European Southern Observatory ESO, Santiago de Chile

<sup>4</sup> LESIA – Observatoire de Paris, France; CAAUL, Observatorio Astronomico de Lisboa, Portugal

<sup>5</sup> Astronomical Department of Padova, Italy

Trans-Neptunian Objects and Centaurs are supposed to be among the most pristine bodies of the Solar System. To investigate their physical properties and their surface composition, an ESO Large Program at the Very Large Telescope was carried out. In this paper we present photometric and spectroscopic near-infrared data of two Centaurs (1998 SG35 and 2000 QC243) and one Trans-Neptunian Object ((47171) 1999 TC36). For (47171) 1999 TC36 and 1998 SG35 visible photometry is also presented. Models of the surface composition of these objects are presented and discussed. By including a small percentage of water ice in our geographical mixtures, we obtain a better agreement with the observations in the H and K bands.

**To appear in: Icarus**

*For preprints, contact Elisabetta Dotto: [dotto@mporzio.astro.it](mailto:dotto@mporzio.astro.it)*

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## The Kuiper Belt as a Resonant Cavity

**William R. Ward<sup>1</sup>**

<sup>1</sup> Southwest Research Institute, Dept. of Space Studies, Suite 400, 1050 Walnut Street, Boulder, CO 80302, USA

The orbital inclinations of a bounded, self-gravitating particle population subject to secular perturbations from an inclined planet are studied. The particle disk is shown to have discrete modes and pattern speeds in which the wave behavior is very pronounced compared with the nonwave behavior. The response is in the form of a standing wave pattern produced by wave reflection at the finite outer edge of the disk. In the absence of dissipation, the perpendicular torque between disk and perturber vanishes, with equal incoming and outgoing angular momentum fluxes carried by the wave trains. This resonant cavity theory is applied to Neptune perturbations of the primordial Kuiper belt. If the nodal precession rate of Neptune was near one of the disk's mode frequencies, very high inclinations could be produced for this population. There are a number of mechanisms in the early solar system that could have tuned the system to pass through one or more resonant states.

**Published in: The Astrophysical Journal Letters, 584, L39 (2003 February)**

*For preprints, contact [ward@boulder.swri.edu](mailto:ward@boulder.swri.edu)*

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# Resonance Occupation in the Kuiper Belt: Case Examples of the 5:2 and Trojan Resonances

E.I. Chiang<sup>1</sup>, A.B. Jordan<sup>1</sup>, R.L. Millis<sup>2</sup>, M.W. Buie<sup>2</sup>, L.H. Wasserman<sup>2</sup>,  
J.L. Elliot<sup>2,3,4</sup>, S.D. Kern<sup>3</sup>, D.E. Trilling<sup>5</sup>, K.J. Meech<sup>6</sup>, and R.M. Wagner<sup>7</sup>

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<sup>4</sup> Department of Physics, MIT, Cambridge, MA 02139, USA

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As part of our ongoing Deep Ecliptic Survey (DES) of the Kuiper belt, we report on the occupation of the 1:1 (Trojan), 4:3, 3:2, 7:4, 2:1, and 5:2 Neptunian mean-motion resonances (MMRs). The previously unrecognized occupation of the 1:1 and 5:2 MMRs is not easily understood within the standard model of resonance sweeping by a migratory Neptune over an initially dynamically cold belt. Among all resonant Kuiper belt objects (KBOs), the three observed members of the 5:2 MMR discovered by DES possess the largest semi-major axes ( $a \approx 55.4$  AU), the highest eccentricities ( $e \approx 0.4$ ), and substantial orbital inclinations ( $i \approx 10^\circ$ ). Objects (38084) 1999HB<sub>12</sub> and possibly 2001KC<sub>77</sub> can librate with modest amplitudes of  $\sim 90^\circ$  within the 5:2 MMR for at least 1 Gyr. Their trajectories cannot be explained by close encounters with Neptune alone, given the latter's current orbit. The dynamically hot orbits of such 5:2 resonant KBOs, unlike hot orbits of previously known resonant KBOs, may imply that these objects were pre-heated to large inclination and large eccentricity prior to resonance capture by a migratory Neptune. Our first discovered Neptunian Trojan, 2001QR<sub>322</sub>, may not owe its existence to Neptune's migration at all. The trajectory of 2001QR<sub>322</sub> is remarkably stable; the object can undergo tadpole-type libration about Neptune's leading Lagrange (L4) point for at least 1 Gyr with a libration amplitude of  $24^\circ$ . Capture mechanisms like those proposed for Jovian Trojans that involve frictional drag in solar nebular gas may be relevant, but with efficiencies likely reduced below the Jovian case because the hydrogen/helium mass fraction of Neptune is small. For an assumed albedo of 12–4%, our Trojan is  $\sim 130$ – $230$  km in diameter. Model-dependent estimates place the total number of Neptune Trojans resembling 2001QR<sub>322</sub> at  $\sim 20$ – $60$ .

**To appear in: The Astronomical Journal**

*For preprints, contact* [echiang@astron.berkeley.edu](mailto:echiang@astron.berkeley.edu)

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

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## 2060 Chiron - Chaotic Dynamical Evolution and its Implications

Ryszard Gabryszewski<sup>1</sup>

<sup>1</sup> Space Research Centre, ul. Bartycka 18A, 00-716 Warszawa, Poland

2060 Chiron—one of the Centaurs orbiting chaotically among the giant planets—is treated as an asteroid and a comet (95P/Chiron) as well. Since the day of the discovery many papers discussed its past and future fate.

This paper considers a possibility of Chiron's dynamical evolution to different cometary orbital types. An ensemble of orbital elements was used to describe Chiron's dynamics in terms of probability. The ensemble was generated using an unique scheme of elements creation. Dispersion of

elements obtained by this method is much smaller comparing to ranges obtained by varying the original elements in the ellipsoid of their mean errors. The chaos in Chiron's dynamical evolution can be seen in 5 to 9 kyrs, although the dispersion of orbital elements is small. Halley type orbits are the rarest noticed orbital types but the number of these objects is 3 times greater than the number of apparent Halley type comets. The variations of probability of different cometary orbits as a function of time is also presented. The rate of HTC orbit production is only 4 times lower than the production rate of JFCs after the first 50 kyrs of integration. Some remarks on small body transportation mechanisms are also included.

**Published in: Acta Astronomica, 52, 305 (2002 September)**

*For preprints, contact* `r.gabryszewski@cbk.waw.pl`

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## 143P/Kowal-Mrkos and the Shapes of Cometary Nuclei

David Jewitt<sup>1</sup>, Scott Sheppard<sup>1</sup>, and Yanga Fernandez<sup>1</sup>

<sup>1</sup> Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822, USA

We add 143P/Kowal-Mrkos to the small but growing sample of well-observed cometary nuclei. Photometric observations from 3.4 to 4.0 AU heliocentric distance reveal a point-like object with no detectable outgassing. Periodic modulation of the scattered light ( $\Delta m_R = 0.45 \pm 0.05$ ) is attributed to rotation of the bare nucleus with a double-peaked period  $17.21 \pm 0.10$  hrs and a projected ratio of the shortest to longest axes of about 0.67/1. We also measured the phase coefficient ( $0.043 \pm 0.014$  mag/deg), the *BVRI* colors ( $V - R = 0.58 \pm 0.02$ ) and the absolute red magnitude ( $m_R = 13.49 \pm 0.20$ ). The effective circular radius is  $5.7 \pm 0.6$  km (geometric albedo 0.04 assumed).

We study the properties of 11 well-observed Jupiter Family Comet (JFC) nuclei. On average, the nuclei are systematically more elongated (average photometric range  $\overline{\Delta m_R} = 0.54 \pm 0.07$ ) than main belt asteroids of comparable size ( $\overline{\Delta m_R} = 0.32 \pm 0.05$ ), and more elongated than fragments produced in laboratory impact experiments. We attribute the elongation of the nuclei to an evolutionary effect, most likely driven by sublimation induced mass loss. However, we find no evidence for any relation between the nucleus shape and the sublimation timescale. This may be because the timescale for evolution of the nucleus shape is very short compared to the dynamical timescale for the JFCs, meaning that most nuclei in our sample are already highly physically evolved.

**To appear in: The Astronomical Journal**

*Preprints available at* <http://www.ifa.hawaii.edu/faculty/jewitt/papers/SHAPES/>

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## PAPERS RECENTLY SUBMITTED TO JOURNALS

### A Generalization of the Lagrangian Points: Studies of Resonances for Highly Eccentric Orbits

A. Margaret Pan<sup>1</sup> and B. Re'em Sari<sup>1</sup>

<sup>1</sup> 130-33 Caltech, Pasadena, CA 91125, USA

Submitted to: The Astronomical Journal

For preprints, contact [mpan@astro.caltech.edu](mailto:mpan@astro.caltech.edu)

or on the web at <http://www.astro.caltech.edu/~mpan/resorbit/>

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## OTHER PAPERS OF INTEREST

### Shock Hugoniot of H<sub>2</sub>O ice

S.T. Stewart<sup>1,2</sup> and T.J. Ahrens<sup>1</sup>

<sup>1</sup> Lindhurst Laboratory of Experimental Geophysics, California Institute of Technology, Pasadena, CA, USA

<sup>2</sup> now at Geophysical Laboratory, Carnegie Institution of Washington, USA

To appear in: Geophysical Research Letters

For preprints, contact [sstewart@gl.ciw.edu](mailto:sstewart@gl.ciw.edu)

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## CONFERENCE CONTRIBUTIONS

### Structure of the Edgeworth-Kuiper Belt (EKB) Dust Disk and Implications for Extrasolar Planet(s) in epsilon Eridani

J.-C. Liou<sup>1</sup>, H.A. Zook<sup>2</sup>, J.S. Greaves<sup>3</sup>, W.S. Holland<sup>3</sup>, H. Boehnhardt<sup>4</sup>, & J.M. Hahn<sup>5</sup>

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<sup>2</sup> NASA Johnson Spaceflight Center, Houston, TX 77058, USA

<sup>3</sup> UK Astronomy Technology Centre, Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ, UK

<sup>4</sup> European Southern Observatory ESO, Alonso de Cordova 3107, Santiago, Chile

<sup>5</sup> Lunar & Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058, USA

To appear in: *Dust in the Solar System and Other Planetary Systems*

(IAU Colloquium 181), p. 225

For preprints, contact [jer-chyi.liou1@jsc.nasa.gov](mailto:jer-chyi.liou1@jsc.nasa.gov)

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### Dust Production in the Kuiper Belt and in Vega-like Systems

C. Dominik<sup>1</sup>

<sup>1</sup> Sterrenkundig Instituut "Anton Pannekoek", Kruislaan 403, 1098 SJ Amsterdam, The Netherlands

To appear in: *Dust in the Solar System and Other Planetary Systems*

(IAU Colloquium 181), p. 229

For preprints, contact [dominik@science.uva.nl](mailto:dominik@science.uva.nl)

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The 34th Lunar and Planetary Science Conference is taking place on 2003 March 17–21 in League City, Texas, USA. Information about the meeting and the program are online at:

<http://www.lpi.usra.edu/meetings/lpsc2003/>

Below are some Kuiper belt-related sessions and papers to be presented at the LPSC that I found. Apologies for any papers that I missed.

- Masursky Lecture. **Kuiper Belt Binaries: A New Window on Runaway Accretion**  
Monday, 2003 March 17, 1:30–2:00 (Salon B)  
P. Goldreich
  
- Session 12. **Moving and Grooving Ice**  
Tuesday, 2003 March 18, 8:30 (Salon A)  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/sess12.pdf>
  - *Cratering Rates in the Outer Solar System*  
K. Zahnle, P. Schenk, L. Dones, and H. Levison  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/1522.pdf>
  
- Session 14. **Digging Deeper: Impact Experiments and Theory**  
Tuesday, 2003 March 18, 8:30 (Salon C)  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/sess14.pdf>
  
- Session 39. **Io and Beyond**  
Wednesday, 2003 March 19, 8:30 (Salon A)  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/sess39.pdf>
  - *An Exploration of Charon's Putative Eccentricity Around Pluto*  
W.F. Bottke, S.A. Stern, and H.F. Levison  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/2113.pdf>
  - *Does the Pluto System Contain Additional Satellites?*  
S.A. Stern  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/1106.pdf>
  
- Session 41. **Asteroids and Comets**  
Wednesday, 2003 March 19, 8:30 (Salon C)  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/sess41.pdf>
  - *The Size Distribution of Jupiter-Family Cometary Nuclei*  
P.R. Weissman and S.C. Lowery  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/2003.pdf>
  
- Session 51. **Origins of Planetary Systems**  
Thursday, 2003 March 20, 8:30 (Salon C)  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/sess51.pdf>
  - *Planetesimal Formation in Two Dimensions: Putting an Edge on the Solar System*  
S.J. Weidenschilling  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/1707.pdf>
  - *The Secular Evolution of the Primordial Kuiper Belt*  
J.M. Hahn  
<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/2121.pdf>



- **Poster Session II. Asteroids and Comets**

Thursday, 2003 March 20, 19:00 (Salon C)

<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/sess75.pdf>

– *A New Approach to Evaluate Collision Probabilities among Asteroids, Comets, and Kuiper Belt Objects*

J.-C. Liou, D.J. Kessler, M.J. Matney, and E.G. Stansbery

<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/1828.pdf>

- **Print-Only Presentations. Origins of Planetary Systems**

<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/sess85.pdf>

– *On an Imparct Origin of Pluto-Charon*

R.M. Canup and E. Asphaug

<http://www.lpi.usra.edu/meetings/lpsc2003/pdf/1828.pdf>

The *Distant EKO*s 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 L<sup>A</sup>T<sub>E</sub>X 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 EKO*s 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 EKO*s 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 EKO*s 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`