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DISTANT EKOs
The Kuiper Belt Electronic Newsletter



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NEWS & ANNOUNCEMENTS

There were 3 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2002 XP114, 2004 NE32, 2004 OL12

and 1 new Centaur/SDO discovery:

2004 PY42

Reclassified objects:

2003 QA91 (SDO → TNO)

2003 QB92 (SDO → TNO)

2004 EG96 (TNO → SDO)

Objects recently assigned numbers:

2001 KF77 = (88269)

2000 OO67 = (87269)

2000 QB243 = (87555)

2003 VB12 = (90377)

1998 HP151 = (85627)

1998 KR65 = (85633)

1999 OY3 = (86047)

1999 RY215 = (86177)

2001 KE76 = (88267)

2001 KK76 = (88268)

2001 QT297 = (88611)

2004 DW = (90482)

2004 GV9 = (90568)

Re-identified objects:

2002 GX32 = 1994 JV (SDO)

Current number of TNOs: 800 (and Pluto & Charon, and 12 other TNO binary companions)

Current number of Centaurs/SDOs: 147

Current number of Neptune Trojans: 1

Out of a total of 948 objects:

463 have measurements from only one opposition

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

199 of those have arcs shorter than 10 days

(for more details, see: http://www.boulder.swri.edu/ekonews/objects/recov_stats.gif)

The Orbit and Albedo of Transneptunian Binary (58534) 1997 CQ₂₉

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We have measured the separations and position angles of the two components of the binary transneptunian object (58534) 1997 CQ₂₉ at eight epochs. From these data we are able to constrain the orbit and mass of this binary system. The best fitting orbit has an orbital period of $P = 312 \pm 3$ days. The orbital eccentricity is $e = 0.45 \pm 0.03$ and the semimajor axis is $a = 8,010 \pm 80$ km. The mass of the system is surprisingly low at $0.42 \pm 0.02 \times 10^{18}$ kg. To account for the observed brightness consistent with the low mass and a range of plausible densities, the geometric albedo must be very high; for an assumed density of 1000 kg m^{-3} we find a red geometric albedo of $p_R = 0.37$, an order of magnitude higher than has been generally assumed for transneptunian objects. If objects with comparably high albedos are common in the Kuiper belt, estimates of the mass of the belt must be significantly reduced. The semimajor axis of (58534) 1997 CQ₂₉'s orbit is 2.8% of the Hill radius of the primary, a value strikingly similar to this same ratio in other transneptunian binaries, main-belt binaries, and regular satellite systems.

To appear in: Icarus

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

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Sculpting the Kuiper Belt by a Stellar Encounter: Constraints from the Oort Cloud and Scattered Disk

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We investigate the effect that a close stellar encounter would have on the growing scattered disk and Oort cloud. Such an encounter has been suggested as the cause of the Kuiper belt's outer edge (Melita et al. 2002). Thus, we restrict our study to encounters that could have caused such a structure. We find that we probably can rule out all such encounters that occurred either at or subsequently to 10 million years after the Oort cloud started to form. In our simulations, these encounters either produce an extended scattered disk that is too populous to be consistent with observations or produces an Oort cloud that is too anemic.

To appear in: The Astronomical Journal

Preprints on the web at http://www.boulder.swri.edu/~hal/passing_star.html

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Simulations of the Populations of Centaurs — I. The Bulk Statistics

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Large-scale simulations of the Centaur population are carried out. The evolution of 23,328 particles based on the orbits of 32 well-known Centaurs is followed for up to 3 Myr in the forward and backward direction under the influence of the four massive planets. The objects exhibit a rich variety of dynamical behaviour with half-lives ranging from 540 kyr (1996 AR20) to 32 Myr (2000 FZ53). The mean half-life of the entire sample of Centaurs is 2.7 Myr. The data are analysed using a classification scheme based on the controlling planets at perihelion and aphelion, previously given in Horner et al. Transfer probabilities are computed and show the main dynamical pathways of the Centaur population. The total number of Centaurs with diameters larger than 1 km is estimated as $\sim 44,300$, assuming an inward flux of one new short-period comet every 200 yr. The flux into the Centaur region from the Edgeworth-Kuiper Belt is estimated to be one new object every 125 yr. Finally, the flux from the Centaur region to Earth-crossing orbits is one new Earth-crosser every 880 yr.

To appear in: Monthly Notices of the Royal Astronomical Society

For preprints, contact horner@phim.unibe.ch

or on the web at <http://arxiv.org/abs/astro-ph/0407400>

Simulations of the Population of Centaurs — II: Individual Objects

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Detailed orbit integrations of clones of five Centaurs — namely, 1996 AR20, 2060 Chiron, 1995 SN55, 2000 FZ53 and 2002 FY36 — for durations of ~ 3 Myr are presented. One of our Centaur sample starts with perihelion initially under the control of Jupiter (1996 AR20), two start under the control of Saturn (Chiron and 1995 SN55) and one each starts under the control of Uranus (2000 FZ53) and Neptune (2002 FY36) respectively. A variety of interesting pathways are illustrated with detailed examples including: capture into the Jovian Trojans, repeated bursts of short-period comet behaviour, capture into mean-motion resonances with the giant planets and into Kozai resonances, as well as traversals of the entire Solar system. For each of the Centaurs, we provide statistics on the numbers (i) ejected, (ii) showing short-period comet behaviour and (iii) becoming Earth and Mars crossing. For example, Chiron has over 60% of its clones becoming short-period objects, whilst 1995 SN55 has over 35%. Clones of these two Centaurs typically make numerous close approaches to Jupiter. At the other extreme, 2000 FZ53 has 2% of its clones becoming short-period objects. About 20% of the clones which become short-period comets subsequently evolve into Earth-crossers.

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For preprints, contact horner@phim.unibe.ch

or on the web at <http://arxiv.org/abs/astro-ph/0408576>

Scenarios for the Origin of the Orbits of the Trans-Neptunian Objects 2000 CR105 and 2003 VB12 (Sedna)

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Explaining the origin of the orbits of 2000 CR₁₀₅ ($a \sim 230$ AU, $q \sim 45$ AU) and 2003 VB₁₂ ($a = 531$ AU, $q = 74$ AU, unofficially known as Sedna) is a major test for our understanding of the primordial evolution of the outer Solar System. Gladman et al. (2001) showed that 2000 CR105 could not have been a normal member of the scattered disk that had its perihelion distance increased by chaotic diffusion. The same conclusion also clearly applies to 2003 VB12. In this paper we explore five seemingly promising mechanisms for explaining the origin of the orbits of these peculiar objects: (i) the passage of Neptune through a high-eccentricity phase, (ii) the past existence of massive planetary embryos in the Kuiper belt or the scattered disk, (iii) the presence of a massive trans-Neptunian disk at early epochs that perturbed high-inclined scattered disk objects, (iv) encounters with other stars that perturbed the orbits of some of the Solar System's trans-Neptunian planetesimals, and (v) the capture of extra-solar planetesimals from low mass stars or brown dwarfs encountering the Sun. Of all these mechanisms, the ones giving the most satisfactory results are those related to the passages of stars (iv and v). An important advantage of both stellar passage scenarios is that all the resulting objects with large perihelion distances also have large semi-major axes. This is in good agreement with the fact that 2000 CR₁₀₅ and 2003 VB₁₂ have semi-major axes larger than 200 AU and no other bodies with similar perihelion distances but smaller semi-major axes have yet been discovered. We favor (iv), since it produces an orbital element distribution that is more consistent with the observations, unless 2000 CR₁₀₅ and 2003 VB₁₂ represent a population more massive than a few tenths of an Earth mass, in which case (iv) is not viable.

To appear in: The Astronomical Journal

Preprints on the web at <http://www.boulder.swri.edu/~hal/CR105.html>

and <http://www.arXiv.org/abs/astro-ph/0403358>

PAPERS RECENTLY SUBMITTED TO JOURNALS

Trans-neptunian Object (55636) 2002 TX₃₀₀ : A Fresh Icy Surface in the Outer Solar System

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Submitted to: Astronomy & Astrophysics Letters

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The Inhomogeneous Surface of Centaur (32522) Thereus 2001 PT₁₃

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Submitted to: Astrophysical Journal Letters

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The Origin of Asymmetric Capture in Migratory Resonances

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Submitted to: The Astrophysical Journal

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or on the web at `http://astron.berkeley.edu/~rmurray/publications.html`

OTHER PAPERS OF INTEREST

King of the Kuiper Belt

Diana Whitman

Published in: Mercury, 33, 17 (2004 May/June)

Comet Nucleus Size Distributions from HST and Keck Telescopes

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Published in: Icarus, 170, 463 (2004 August)

Pumping of a Planetesimal Disc by a Rapidly Migrating Planet

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To appear in: The Monthly Notices of the Royal Astronomical Society

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Available online at: <http://arxiv.org/abs/astro-ph/0409017>

CONFERENCE CONTRIBUTIONS

Formation and Migration of Trans-Neptunian Objects

S.I. Ipatov¹

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To appear in: Proceedings of the 14th Annual Astrophysics Conference in Maryland; "The Search for Other Worlds", ed. by S.S. Holt and D. Deming, American Institute of Physics, 2004, pp. 277-280

For preprints, contact ipatov@stars.gsfc.nasa.gov

or on the web at <http://www.arXiv.org/abs/astro-ph/0401279>

THESES

Chaotic Diffusion in the Outer Solar System and Other Topics

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We carried out extensive numerical orbit integrations to probe the long-term chaotic dynamics of the 2:3 (Plutinos) and 1:2 (Twotinos) mean motion resonances with Neptune. We derive maps of resonance stability measured both by time-averaged particle density and by mean dynamical diffusion rate, and investigate the effects of a massive perturber embedded in the resonance. We also investigate the population of Resonant Kuiper Belt Objects at 4 Gyr ago compared to the present, and discuss the implications for theories of Kuiper Belt origins.

We have numerically investigated the long term dynamical behavior of known Centaurs. We find that their orbital evolution is characterized by frequent close encounters with the giant planets, with no significant long-term resonant behavior. Most of these Centaurs will escape from the inner solar system, while a fraction will enter the Jupiter-family comet (JFC) population and a few percent will impact a giant planet. We discuss the implications of our study for the spatial distribution of the actual Centaur population.

Using numerical and analytical models, we investigate the ejection of water molecules from Europa's surface by sputtering, the subsequent evolution of their ballistic trajectories, and their re-deposition onto the surface as a water frost. We conclude that net deposition does occur under certain conditions, making sputtering erosion and re-deposition a plausible explanation for the observed color dichotomy between Europa's leading and trailing hemispheres.

During Cassini's approach to Jupiter, a series of images was taken to search for any undiscovered satellites of Jupiter. Our analysis of these images indicates that no undiscovered satellites exist between 2.6 and 20 R_J with inclination $i < 1.6^\circ$, eccentricity $e < 0.0002$, diameter $D > 15$ km and albedo $A > 0.1$.

Dissertation directed by Renu Malhotra.

Ph.D. awarded in August, 2004, from the University of Arizona.

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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 \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 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.

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Moving ... ??

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`ekonews@boulder.swri.edu`