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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

The discovery that 2003 UN_{284} is a binary TNO was announced in IAUC 8251 by Millis et al.. At discovery, the components had a separation of 2.01 ± 0.11 arcsec (~61000 km at 42 AU) and a broad-VR-bandpass magnitude difference of 0.59 ± 0.21 mag.
IAUC: `http://cfa-www.harvard.edu/iauc/08200/08251.html`

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There were 36 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2003 VS2, 2003 UN284, 2003 WU172, 2003 UA292, 2003 UB292, 2003 UC292, 2003 UD292, 2003 UE292, 2003 UF292, 2003 UG292, 2003 UH292, 2003 UJ292, 2003 UK292, 2003 UL292, 2003 UM292, 2003 UN292, 2003 US291, 2003 UT291, 2003 UU291, 2003 UV291, 2003 UW291, 2003 UX291, 2003 UY291, 2003 UZ291, 2003 WQ188, 2003 UO292, 2003 UP292, 2003 UQ292, 2003 UR292, 2003 US292, 2003 UT292, 2003 UU292, 2003 UV292, 2003 UX292, 2003 UZ292, 2003 WS188

and 4 new Centaur/SDO discoveries:

2003 WL7, 2003 WT42, 2003 UW292, 2003 UY292

Reclassified objects:

2003 UY117 (TNO → SDO)
2003 QB92 (TNO → SDO)
2003 QE112 (TNO → SDO)
2003 QH91 (TNO → SDO)

Objects recently assigned numbers:

2002 PN34 = (73480)
1998 WA31 = (69988)
1998 WA25 = (69987)
1998 WU31 = (69990)
1998 WW24 = (69986)

Current number of TNOs: 760 (and Pluto & Charon, and 11 other TNO binary companions)
Current number of Centaurs/SDOs: 148
Current number of Neptune Trojans: 1

Out of a total of 909 objects:

462 have measurements from only one opposition
343 of those have had no measurements for more than a year
190 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

The Formation of the Kuiper Belt by the Outward Transport of Objects During Neptune's Migration

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The "dynamically cold Kuiper belt", which consists of objects on low inclination orbits between ∼40 and 50 AU from the Sun, currently contains less than 1/10 Earth-masses of material. This value is surprisingly low because, accordinging to accretion models, the objects observed there would not have grown to their present size unless the cold Kuiper belt originally contained tens of Earth-masses of solids. While several mechanisms have been proposed to produce the observed mass depletion, all have significant limitations. Here we show that the objects currently observed in the dynamically cold Kuiper belt were most likely formed interior to 35 AU and were pushed outward by Neptune's 1:2 mean motion resonance during its final phase of migration. Combining our mechanism with previous works, we conclude that the entire Kuiper belt formed closer to the Sun and was transported outward during the final stages of planet formation.

Published in: Nature, 426, 419 (2003 November 27)

For preprints, contact `hal@gort.boulder.swri.edu`

or on the web at `http://www.boulder.swri.edu/~hal/push-out.html`

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A Search for Debris Disks Around Stars with Giant Planets

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Eight nearby stars with known giant planets have been searched for thermal emission in the submillimetre arising from dust debris. The null results imply quantities of dust typically less than 0.02 Earth-masses per star. Conversely, literature data for 20 Sun-like stars with debris disks show that $\leq 5\%$ have gas giants inside a few AU — but the dust distribution suggests that nearly all have more distant planets. The lack of overlap in these systems — i.e. few stars possess both inner planets and a disk — indicates that these phenomena are either not connected or are mutually exclusive. Comparison with an evolutionary model shows that debris masses are predicted to be low by the stellar ages of 2–8 Gyr (unless the colliding parent bodies are quite distant, located beyond 100–200 AU), but it remains to be explained why stars that *do* have debris should preferentially only have distant planets. A simple idea is proposed that could produce these largely different systems, invoking a difference in the primordial disk mass. Large masses promote fast gas giant growth and inwards migration, whereas small masses imply slow evolution, low-mass gas giants and outwards migration that increases the collision rate of Kuiper Belt-like objects. This explanation neglects other sources of diversity between disks (such as density and planetesimal composition and orbits), but it does have the merit of matching the observational results.

To appear in: Montly Notices of the Royal Astronomical Society

For preprints, contact `jsg@roe.ac.uk`

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Resonant Structure in the Kuiper Disk: An Asymmetric Plutino Disk

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In order to develop a dynamical model of the Kuiper disk, we run numerical integrations of particles originating from source bodies trapped in the 3:2 external mean motion resonance with Neptune to determine what percentage of particles remain in the resonance for a variety of particle and source body sizes. The dynamical evolution of the particles is followed from source to sink with Poynting-Robertson light drag, solar wind drag, radiation pressure, the Lorentz force, neutral interstellar gas drag, and the effects of planetary gravitational perturbations included. We find that the number of particles in the 3:2 resonance increases with decreasing β (i.e., increasing particle size) for the cases where the initial source bodies are small (≤ 10 km in diameter) and that the percentage of particles in resonance is not significantly changed by either the addition of the Lorentz force, as long as the potential of the particles is small ($\approx 5\ V$), or the effect of neutral interstellar gas drag. The brightness of the entire Kuiper disk is calculated using a model composed of 500 μm diameter particles, and fits well with upper limits to the Kuiper disk brightness and previous estimates. A disk with a size-frequency distribution weighted towards large particles, which are more likely to remain in resonance, may have a stronger, more easily identifiable resonant signature than a disk composed of small particles.

Published in: The Astrophysical Journal, 597, 1211 (2003 November 10)

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The Dynamics of Known Centaurs

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We have numerically investigated the long-term dynamical behavior of known Centaurs. This class of objects is thought to constitute the transitional population between the Kuiper belt and the Jupiter-family comets (JFCs). In our study, we find that over their dynamical lifetimes these objects diffuse into the JFCs and other sinks, and they also make excursions into the scattered disk, but (not surprisingly) do not diffuse into the parameter space representing the main Kuiper belt. These Centaurs spend most of their dynamical lifetimes in orbits of eccentricity 0.2–0.6 and perihelion distance 12–30 AU. Their orbital evolution is characterized by frequent close encounters with the giant planets. Most of these Centaurs will escape from the solar system (or enter the Oort cloud), while a fraction will enter the JFC population and a few percent will impact a giant planet. Their median dynamical lifetime is 9 Myr, although there is a wide dispersion in lifetimes, ranging from less than 1 Myr to more than 100 Myr. We find the dynamical evolution of this sample of Centaurs to be less orderly than the planet-to-planet "handoff" described in previous investigations. We discuss the implications of our study for the spatial distribution of the Centaurs as a whole.

Published in: The Astronomical Journal, 126, 3122 (2003 December)

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Size Estimate of Some Optically Bright KBOs

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Seven recently detected optically "bright" Kuiper-Belt-Objects (KBOs) were observed at 250 GHz using the Max-Planck Millimeter Bolometer (MAMBO) array at the IRAM 30 m telescope. Only the optical binary KBO (47171) 1999 TC36 was detected, whose components differ optically by $\Delta m \approx 2$. Assuming that the derived mean geometric albedo of $p = 0.05$ is identical for both, the component diameters become 566 and 225 km. For the other six objects upper limits to their sizes and lower limits for their albedos were obtained. The geometric albedo, p, for (28978) Ixion is surprisingly large, $\geq$0.15. For a consistent comparison all published radio photometric data of KBOs and Centaurs were analyzed again: the average geometric albedo is found to be ≈ 0.08.

To appear in: Astronomy & Astrophysics
For preprints, contact wja@mpifr-bonn.mpg.de

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The Absolute Magnitude Distribution of Trans-Neptunian Objects

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It is shown that the known trans-Neptunian objects (TNOs) have an absolute magnitude distribution index that increases as a function of orbital perihelion distance. In no perihelion range is the TNO index the same as that found for known short-period comets. However, the fact that the median diameters of the known members of these two populations (220 and 2.9 km respectively) differ by a factor of about 75 means that very small TNOs and short-period comets might still be related.

Published in: Monthly Notices of the Royal Astronomical Society, 345, 981
For preprints, contact D.Hughes@sheffield.ac.uk

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A Rotational Light Curve for the Kuiper Belt Object 1997 CV_{29}

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We present R- and V-band rotational light curves for classical Kuiper belt object 1997 CV_{29}. The imaging data was obtained from the Canada-France-Hawaii Telescope (CFHT) archive located at the Canadian Astronomical Data Center (CADC). The data consist of one night's observations of a series of 42, 8 minute exposures in R band followed by 33, 8 minute exposures in V band acquired on the following night. Using relative photometry we determined a highly significant variation in the brightness of 1997 CV_{29}. Using Phase-Dispersion-Minimization we find 8.0, 11.2 and 15.8 hours to be the most likely periods of rotation and we argue that the $\sim$16 hour period is the most likely based on our limited observing window. The phased light curve has a peak-to-peak range of $\Delta m \gtrsim 0.4 \pm 0.1$ mag suggesting an axial ratio of $a/b \gtrsim 1.45$.

To appear in: Icarus, 167, 220 (2004 January)
For preprints, contact jjk@hia.nrc.ca

[The following papers all appeared in a special September 2003 issue of *Comptes Rendus Physique*, Volume 4, Issue 7, Pages 731-817. "New frontiers in the Solar System: Trans-Neptunian Objects" (A. Barucci, editor). The journal can be found online at: `http://www.sciencedirect.com`]

The Discovery and Exploration of the Trans-Neptunian Region

John Keith Davies[1]

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First predicted qualitatively in the 1940s, quantitatively in the 1980s and finally discovered in the 1990s, the planetesimals beyond Neptune provide a fossil record of the early history of the solar system. A decade of observations have shown that the region is far more complicated, both dynamically and compositionally, than originally suspected and it continues to challenge both observers and modellers who attempt to understand it. This region of space provides an observational link between evolved planetary systems like the solar system and the disks of material recently detected around other nearby Sun-like stars.

Published in: Comptes Rendus Physique, 4, 733

Discovering and Securing TNOs: the CFHTLS Ecliptic Survey

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We have developed an international collaboration aimed at discovering and long-term tracking of a large Trans-Neptunian Object (TNO) sample. The scientific rationale behind this extended observational effort is to understand the dynamical structure of the outer Solar System. This structure provides a unique tracer of planetary accretion processes and constrains models of formation and early evolution of our outer Solar System.

Our observational program is designed to first discover a large sample of TNOs in well characterized surveys and then track them in a manner which will avoid what we call 'follow-up bias'.

We first briefly describe the current status of our current observational knowledge of the Kuiper Belt. Next we show how following-up almost all objects discovered in a survey has changed our view of the dynamical structure of the Kuiper Belt. Thanks to our work, previously empty places have been filled in, the relative importance of the then known dynamical population have been largely modified, and a new, potentially very large, population have been discovered. Discoveries presented in this paper were done at CFHT, while recoveries were performed on multiple telescopes, including in particular the ESO telescopes and the MPIA telescopes in Calar Alto (Spain).

Finally, we briefly describe the ecliptic component of the CFHT Legacy Survey for which Kuiper Belt science is the main driver. Our experience with discovery and follow-up observations has led us to design an efficient time-sequence of observations for this survey.

Published in: Comptes Rendus Physique, 4, 743

Multicolour Photometry of Trans-Neptunian Objects: Surface Properties and Structures

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Trans-Neptunian Objects (TNOs) and Centaurs display the widest colour range among solar system objects. Moreover, recent observational results revealed: (1) the existence of a family of classical TNOs (also called Cubewanos) with very red colours in dynamically 'cold' orbits beyond about 40 AU from the Sun; and (2) a few correlations among the dynamically 'hot' Cubewanos. Other TNO populations and the Centaurs show no obvious and systematic trends. The article describes the observations and reduction techniques applied for the photometry of these distant and faint solar system objects and provides a brief overview on the results and their links with formation and evolution scenarios of these primitive bodies in the outer solar system.

Published in: Comptes Rendus Physique, 4, 755

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A Statistical Insight into the Edgeworth-Kuiper Belt

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Ten years after the discovery of the first object entirely outside the orbit of Neptune, the number of detected Edgeworth-Kuiper Belt objects (EKBO) is close to 800: after the discovery of the asteroid 1 Ceres, it took 115 years to discover the same number of asteroids. These large comets dressed as asteroids are very elusive objects, challenging the observers with their faintness. As well as the comets and the asteroids, this group of objects represent a valuable source of information on the physical and chemical environment of the Solar System at the epoch of planet growth. In this paper we summarize the results of the first statistical studies of the bulk physical and chemical properties of EKBO, based on broad band photometry data.

Published in: Comptes Rendus Physique, 4, 767

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Surface Composition of TNOs and Centaurs: Visible and Near-infrared Spectroscopy

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Visible and near-infrared spectroscopy is the most effective technique to investigate the surface composition of atmosphereless bodies. However, the intrinsic faintness of Trans-Neptunian Objects (TNOs) and Centaurs imposes strong observational limits, and the sample of available information on these objects is still rather limited. Visible and near-infrared spectra, as well as models of the surface compositions, are today available only for about fifteen objects among TNOs and Centaurs.

The most evident property is the huge variety of spectral features, physical characteristics, and compositions. This poses still unanswered questions about the origin and the early evolution of these small bodies.

Published in: Comptes Rendus Physique, 4, 775

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Quantitative Modeling of the Spectral Reflectance of Kuiper Belt Objects and Centaurs

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Reflectance spectroscopy of Solar System bodies provides a rich source of information on their compositions (minerals, ices, metals, and macromolecular carbon-bearing materials). Models calculated with radiative transfer theories for the spectral distribution of diffusely scattered sunlight from planetary surfaces yield information on the compositions, abundances, physical states, layering, and particle microstructure of those surfaces. We discuss and evaluate the scattering theories of Hapke and Shkuratov that are widely used for modeling the reflectance spectra and color data for Kuiper Belt objects, Centaur objects, and other airless bodies in the Solar System. Both theories yield good models of the reflectance spectrum of Centaur 5145 Pholus using five components (ices, carbon, a silicate mineral, and a complex organic material), although the derived abundances differ widely.

Published in: Comptes Rendus Physique, 4, 783

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Ion Irradiation of TNOs: from the Fluxes Measured in Space to the Laboratory Experiments

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Cosmic ion irradiation is believed to be one of the processes driving the evolution of the surface materials on TNOs. We review the laboratory simulations of radiation effects induced in likely TNO materials. In particular the production of new molecular species, the formation of refractory organics, and the spectral changes induced in icy targets and in natural bitumens are described. In order to establish if the effects seen in the laboratory are in fact responsible for the surface properties of the TNOs, the present knowledge of the ion fluxes is reviewed. For objects at selected solar distances, dosage time is given versus depth into the material. As suggested by recent experiments, the contribution of the electronic energy loss and that due to knock-on collisions are given separately. The relevance of ion-irradiation for the physico-chemical properties of TNOs is demonstrated, and the need for future investigations is outlined.

Published in: Comptes Rendus Physique, 4, 791

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Collisions, Accretion, and Erosion in the Kuiper Belt

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Collisional modeling has been a fertile area of Kuiper Belt research for almost a decade. Such modeling has yielded important results concerning expected KBO surface properties, the KBO size distribution, the origin of KBOs and the properties of the primoridal Kuiper Belt, and most recently, the formation of KBO satellites. In what follows we briefly review some isolated aspects of these research results. A far more comprehensive, but older review of this topic was provided by Farinella et al. (in: Protostars and Planets IV, Mannings et al. (Eds.), University of Arizona Press, 2001).

Published in: Comptes Rendus Physique, 4, 803

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The Primordial Sculpting of the Kuiper Belt

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Understanding how the Kuiper belt acquired its puzzling present orbital structure will provide insight into the formation of the outer planetary system and on its early evolution. We outline a scenario of primordial sculpting — issued from a combination of mechanisms proposed by various authors — that seems to explain most of the observed properties of the Kuiper belt. Several aspects are not yet totally clear, and some may not be totally correct. But, for the first time, we have a view — if not of the detailed sculpture — at least of its rough cast.

Published in: Comptes Rendus Physique, 4, 809

CONFERENCE INFORMATION

Effects of Space Radiation on Solar System Ices

a session of the Asia-Oceania Geosciences Society Annual Meeting and Exhibition
2004 July 5-9
Suntec City, Singapore

`http://www.asiaoceania.org/proposals/sp/sp2.htm`
`http://www.asiaoceania.org/confer.html`

Many Solar System objects, such as planets, satellites, rings, and comets, are known to either be made of ices or to have icy surfaces. Because these ices are subjected to radiation processing by keV-MeV ions and UV-photons, their chemical and physical properties evolve over time. This session will focus on recent laboratory experiments involving photon and ion processing of important Solar System and interstellar ices. Examples of topics to be included are near- and mid-IR measurements of processed ice signatures and residues, and their application to astronomical observations. Radiation environments and the relevant parameters for simulation experiments will also be covered by the speakers.

For more information contact:

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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 ... ??

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