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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

Bob Marcialis has compiled extensive bibliographies of Pluto and Chiron references. They can be found at: `http://www.lpl.arizona.edu/~umpire/science/plubib.html`
and `http://www.lpl.arizona.edu/~umpire/science/2060bib.html`
Links to these and other reference lists are on the *Distant EKOs* website:
`http://www.boulder.swri.edu/ekonews/articles/`

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At the recent meetings of IAU Commission 20, the Working Group on Comets has been revised to include Centaurs and trans-Neptunian objects. Some of the tasks of the newly named Working Group on Comets and Distant Objects are:

- to advise on observational procedures regarding the distinction between low-activity comets and asteroids, and on extending the range of heliocentric distances where comets are observed;
- to advise on ways of improving knowledge of the distribution of orbits in the outer Solar System by augmenting the sample of distant objects with well-determined orbits and ensuring optimal treatment of the resulting data;
- to consider methodological issues concerning numerical modelling of the dynamics in the outer planetary region and of objects on unstable, planet-crossing orbits in general;
- to consider methodological issues concerning astrometric observations of distant objects, and to help in providing guidelines (in particular, to secure adequate follow-up observations of Transneptunian Objects);
- to recommend terminology for the distant-object population and its subsets.

The Working Group consists of 18 members from 10 countries. Input from the Transneptunian research community about the Working Group and its charge is strongly desired. Questions and comments may be addressed to the chair, Brian Marsden, at: `bmarsden@cfa.harvard.edu`.

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Objects with recently assigned numbers and names:
1995 DW2 (10370) Hylonome
1992 QB1 (15760)
1993 SB (15788)
1993 SC (15789)
1994 GV9 (15807)
1994 JS (15809)
1994 JR1 (15810)
1994 TB (15820)
1995 DA2 (15836)
1996 TL66 (15874)
1996 TP66 (15875)
1997 CR29 (15883)

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There were 5 new TNO discoveries announced since the previous issue of the *Distant EKOs*:
1999 DF9, 1999 CL158, 1999 CM158, 1999 RZ253, 2000 GP183
and 3 new Centaur/SDO discoveries:
1996 RX33, 2000 OB51, 2000 OY51

Current number of TNOs: 287 (and Pluto & Charon)
Current number of Centaurs/SDOs: 49

PAPERS ACCEPTED TO JOURNALS

Compositional Surface Diversity in the Trans-Neptunian Objects

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The knowledge of the physical and chemical properties of Trans-Neptunian Objects (TNOs) is still incomplete and confused. To investigate their physical properties, we are continuing at ESO with the 3.5 m telescope (NTT) the TNO observational programme started in 1997. In February 1999, broad band optical colors were obtained for eight new objects: 1993 FW, 1995 HM_5, 1997 CQ_{29}, 1997 CS_{29}, 1997 CT_{29}, 1997 CU_{29}, 1998 FS_{144}, and 1998 WH_{24}. Particular attention has been applied to the observations and data reduction of these faint objects. These new data increase the available statistical sample and will help us to understand the surface properties and the mechanisms of the surface modification of the TNOs. The observed objects present a wide spread of colors. The color distribution does not show any bimodality. Knowledge of the colors of a large number of these objects will be important to understand this population, which represents an important reservoir of primordial material.

Published in: The Astronomical Journal, 120, 496 (2000 July)

For preprints, contact `antonella.barucci@obspm.fr`

or on the web at `http://despa.obspm.fr/~tno/publi_e.htm`

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Observations of the Trans-Neptunian Objects 1993 SC and 1996 TL66 with the Infrared Space Observatory

Nicolas Thomas[1], S. Eggers[1], W.-H. Ip[1,2], G. Lichtenberg[1], A. Fitzsimmons[3], L. Jorda[1], H. U. Keller[1], I. P. Williams[4], G. Hahn[5], and H. Rauer[5]

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Observations at 90 μm of the trans-Neptunian objects (TNOs), 1993 SC and 1996 TL66, using the *Infrared Space Observatory (ISO)* are reported. Five individual observations of 1993 SC were acquired giving a 2.7σ detection (a confidence level of 99.6%). The signal level of 11.46 ± 4.24 mJy has been modeled using a standard thermal model (STM) and gives an effective radius of 164^{+29}_{-33} km and a geometric albedo of $0.022^{+0.013}_{-0.006}$. Estimated radii and albedos using the fast rotator approximation and the thermophysical model are also presented. Two individual observations of 1996 TL66 are also reported. A clear signal of 39.77 ± 11.62 mJy at 90 μm was recorded. However, the position of the signal on the detector does not correspond to the position expected. A detailed investigation has not revealed a satisfactory explanation. Assuming that *ISO* was mispointed and that the origin of the signal is 1996 TL66, application of the STM gives an effective radius of 316^{+42}_{-49} km and a geometric albedo of $0.030^{+0.012}_{-0.007}$. This is in good agreement with expectations based on the assumption that the surfaces of TNOs are similar to those of cometary nuclei. The results for 1996 TL66 and 1993 SC

indicate that TNOs are large, spherical, and very dark objects. A main-belt asteroid, 1997 SU15, was also detected giving an effective radius of 1.13 ± 0.04 km and a geometric albedo of 0.25 ± 0.02. An estimate of the relative dependence of the zodiacal light background in the ecliptic on elongation angle at 90 m was also determined.

Published in: The Astrophysical Journal, 534, 446 (2000 May 1)
Available on the web at
`http://www.journals.uchicago.edu/ApJ/journal/issues/ApJ/v534n1/40276/40276.html`

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Infrared Spectroscopy of the Centaur 8405 Asbolus: First Observations at ESO-VLT

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Centaurs constitute a separate population of Solar System objects, with orbits crossing one or more of the giant planets' orbits. They are located on unstable orbits with short lifetimes, and are probably transition objects between Trans-Neptunians and short-period comets. We present near-infrared spectroscopic observations of one of the Centaurs, 1995 GO, now named 8405 Asbolus, carried out at the ESO-Very Large Telescope (Mount Paranal, Chile) in May 1999. Spectra obtained in the J, H, and K bands show a rather featureless behavior with, in particular, no detection of H_2O ice.

Published in: Astronomy & Astrophysics, 357, L53 (2000 May)
For preprints, contact `antonella.barucci@obspm.fr`
or on the web at `http://despa.obspm.fr/~tno/publi_e.htm`

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Near-infrared Spectroscopy of the Bright Kuiper Belt Object 2000 EB173

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We have obtained a near-infrared spectrum of the bright Kuiper belt object 2000 EB173; the spectrum appears featureless. The spectrum has sufficient signal-to-noise to rule out 1.5 and 2.0 μm absorption from water ice even at the low level seen in the Centaur Chariklo. In addition we can rule out 2.3 μm absorption at the level seen in the Centaur Pholus.

To appear in: Astrophysical Journal Letters
For preprints, contact `mbrown@gps.caltech.edu`
or on the web at `http://www.gps.caltech.edu/~mbrown/papers`

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The Distribution and Physical State of H_2O on Charon

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We present new 1.4-2.5 μm geometric albedo spectra of Charon taken with HST/NICMOS in 1998. These new data provide global coverage of the surface with four spectra at evenly spaced longitudes. The surface of Charon is seen to be globally dominated by H_2O ice. The data indicate the ice is in the crystalline phase at a temperature consistent with its heliocentric distance. The spectrum of Charon has only weak variations with longitude. There is an indication of a slightly stronger H_2O ice absorption on the leading hemisphere. No variations in the spectrum are seen in response to differing solar phase angle. From model fits there is no indication of any of the volatile species that are seen on Pluto, i.e., CO, CH_4, or N_2. There is spectroscopic evidence for a contaminant with an absorption coefficient which increases with wavelength past $\sim$2 μm. This contaminant is unidentified but is similar to what is seen on other icy satellites in the outer solar system. We also present a standard spectrophotometric model for Charon that can be used to subtract Charon light from ground based spectra of the combined Pluto-Charon system.

To appear in: Icarus

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Search for Variations in Pluto's Millimeter-Wave Emission

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We report on repeated bolometric observations of the Pluto–Charon system at 1.2 mm with the IRAM 30-m telescope. These observations indicate at most little ($\sim$1–2 mJy) variations of the millimeter-wave emission of Pluto with orbital longitude, suggesting that the dark regions of Pluto have a millimeter emissivity of $\sim$0.6-0.7.

To appear in: Icarus

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Evolution of Porosity in Small Icy Bodies

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In this paper we consider self-compaction of icy bodies with radii from 60 to 200 km. They could be some of the icy satellites of the giant planets and some of the Kuiper belt objects. It is assumed that the considered globes were formed as porous bodies by the process of homogeneous accretion. They are not products of disruptive collisions. The evolution is considered from an early stage of formation (the embryo stage), through the stage when accretion is completed (present-day mass is settled), until the time when the present state (present-day radius, as well as the moment of inertia, if available) is reached.

The model we use to calculate the evolution of the distributions of density (or porosity) and of temperature is based on that presented by Kossacki and Leliwa-Kopystynski (1993. Planet. Space Sci. 41(10), 729-741). The model can be applied with various rheological formulae for pressure- and temperature-dependent compaction of granular, initially porous, icy-mineral medium. The bodies under consideration are assumed to be composed of water ice with an admixture of ammonia and of silicates. The components are uniformly distributed with a mass ratio C of silicates to total being fixed. An abundance x of ammonia relative to water is one of the crucial parameters of the model. The internal sources of energy leading to the evolution are: (i) the gravitational energy of initially porous globes; and (ii) the energy of radioactive decay of radionuclides dispersed within the mineral component. The amount of long lived isotopes is that corresponding to chondritic meteorites. Moreover, an initial presence of short lived Al^{26} is not excluded a priori. Its initial abundance is another parameter of the model.

The particular examples of calculations concern bodies with the sizes and densities of Mimas, Janus and Epimetheus. The three-dimensional (3-D) presentation of the results has allowed us to estimate physically reasonable ranges for ammonia and Al^{26} contents.

Published in: Planetary and Space Science, 48, 727 (2000 June)

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Orbit Fitting and Uncertainties for Kuiper Belt Objects

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We present a procedure for determination of positions and orbital elements, and associated uncertainties, of outer Solar System planets. The orbit-fitting procedure is greatly streamlined compared to traditional methods because acceleration can be treated as a perturbation to the inertial motion of the body. These techniques are immediately applicable to Kuiper Belt Objects, for which recovery observations are costly. Our methods produce positional estimates and uncertainty ellipses even in the face of the substantial degeneracies of short-arc orbit fits; the sole *a priori* assumption is that the orbit should be bound or nearly so. We use these orbit-fitting techniques to derive a strategy for determining Kuiper Belt orbits with a minimal number of observations.

Orbit-fitting software is available via: `http://www.astro.lsa.umich.edu/users/garyb`

To appear in: The Astronomical Journal

Preprints available on the web at `http://arXiv.org/abs/astro-ph/0008348`

Comparative Study of Mean-Motion Resonances in the Trans-Neptunian Region

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In this work we are interested in the present dynamical structure of the trans-neptunian region. It is known that at moderate to high eccentricities, stable orbits lie close to an exterior-mean-motion resonance with Neptune (NMMR). We study some NMMRs under different points of view. Intrinsic probabilities of collision and dynamical diffusion time-scales using frequency-map analysis have been computed. We have found that collisions and gravitational encounters by themselves would not produce remarkable differences between the number of objects orbiting in each resonance at present. However, frequency-map analysis reveals a much more robust region at the 2:3 NMMR than at the other NMMRs. Naturally the net orbital effect of the encounters can be enhanced differently in each individual NMMR due to differences in size of the stable niches, allowing the populations in the more unstable regions to evaporate sooner. We also study how certain evolutionary models, related with the orbital expansion of the outer planets during their formation stage, could result in resonant populations with a noticeably different primordial number of members. Finally, our results are discussed with reference to the present observational evidence and to our current understanding of the formation of the outer Solar System.

Published in: Icarus, 147, 205 (2000 September)
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Planetary Migration and Plutinos Orbital Inclinations

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I investigate which mechanisms could have acted during Neptune's past radial migration to excite plutinos orbital inclinations to their present values. These processes include Kozai resonance and the ν_{18} secular resonance, both prior to and after the plutino's capture into the 2:3 mean motion resonance with Neptune. In the case ν_{18} acted before the 2:3 resonance encounter, the plutino would have been originally formed near 34 AU. If the plutino was captured near the beginning of the migration process at around 30.5 AU then the secular resonance must have acted inside the 2:3 resonance with high amplitude libration. In this case, the libration amplitude must damp either during the migration by some dynamical process or after migration through dynamical scattering by other Kuiper Belt objects, thus making the final orbit stable. All plutinos with well determined orbits and inclination above 10° seem to have suffered secular resonance.

To appear in: The Astronomical Journal
For preprints, contact rodney@on.br

A Wide-Field CCD Survey For Centaurs and Kuiper Belt Objects

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A modified Baker-Nunn camera was used to conduct a wide-field survey of 1428 deg^2 of sky near the ecliptic in search of bright Kuiper Belt objects and Centaurs. This area is an order of magnitude larger than any previously published CCD survey for Centaurs and Kuiper Belt Objects. No new objects brighter than red magnitude $m_R = 18.8$ and moving at a rate $1''$ hr^{-1} to $20''$ hr^{-1} were discovered, although one previously discovered Centaur 1997 CU26 Chariklo was serendipitously detected. The parameters of the survey were characterized using both visual and automated techniques. From this survey the empirical projected surface density of Centaurs was found to be $\Sigma_C(m_R \leq 18.8) = 7.8(^{+16.0}_{-6.6}) \times 10^{-4}$ deg^{-2} and we found a projected surface density 3σ upper confidence limit for Kuiper Belt objects of $\Sigma_K(m_R \leq 18.8) < 4.1 \times 10^{-3}$ deg^{-2}. We discuss the current state of the cumulative luminosity functions of both Centaurs and Kuiper Belt objects. Through a Monte Carlo simulation we show that the size distribution of Centaurs is consistent with a $q \sim 4$ differential power law, similar to the size distribution of the parent Kuiper Belt Objects. The Centaur population is of order 1×10^7 (radius $\geq$1 km) assuming a geometric albedo of 0.04. About 100 Centaurs are larger than 50 km in radius, of which only 4 are presently known. The current total mass of the Centaurs is 10^{-4} $M_\oplus$. No dust clouds were detected resulting from Kuiper Belt object collisions, placing a 3σ upper limit < 600 collisionally produced clouds of $m_R < 18.8$ per year.

To appear in: The Astronomical Journal (2000 November)
For preprints, contact `sheppard@ifa.hawaii.edu`
or on the web at `http://arXiv.org/abs/astro-ph/0008445`

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Signatures of Exo-solar Planets in Dust Debris Disks

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We apply our recently elaborated, powerful numerical approach to the high-resolution modeling of the structure and emission of circumstellar dust disks, incorporating all relevant physical processes. Specifically, we examine the resonant structure of a dusty disk induced by the presence of one planet. It is shown that the planet, via resonances and gravitational scattering, produces (1) an asymmetric resonant dust belt with one or more clumps intermittent with one or a few off-center cavities; and (2) a central cavity void of dust. These features can serve as indicators of a planet embedded in the circumstellar dust disk and, moreover, can be used to determine its major orbital

parameters and even the mass of the planet. The results of our study reveal a remarkable similarity with various types of highly asymmetric circumstellar disks observed with the James Clerk Maxwell Telescope around Epsilon Eridani and Vega. The proposed interpretation of the clumps in those disks as being resonant patterns is testable – it predicts the asymmetric design around the star to revolve, viz., by 1.2°–1.6° yr^{-1} about Vega and 0.6°–0.8° yr^{-1} about ϵ Eri.

Published in: The Astrophysical Journal Letters, 537, L147 (2000 July 10)
For preprints, contact ozernoy@science.gmu.edu
or on the web at http://arXiv.org/abs/astro-ph/0007014

PAPERS RECENTLY SUBMITTED TO JOURNALS

The Size Distribution of the Kuiper Belt Objects

Cheng-Pin Chen and Ing-Guey Jiang
Academia Sinica, Institute of Astronomy and Astrophysics, Taipei, Taiwan
Submitted to: The Astrophysical Journal Letters
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or on the web at http://arXiv.org/abs/astro-ph/0008171

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Distribution of Dust from Kuiper Belt Objects

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Submitted to: Planetary and Space Science
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or the web at http://arXiv.org/abs/astro-ph/0006435

OTHER ARTICLES

Into the Outer Limits

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Published in: Astronomy, 28, 52 (2000 September 1)

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CONFERENCE PAPERS

Constraints on Collisional Evolution in the Edgeworth-Kuiper Belt: Exploiting The "Vesta Crust" Paradigm

D. D. Durda[1], **S. A. Stern**[1], **J. I. Lunine**[2], **and A. Morbidelli**[3]

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To appear in: 32nd Annual DPS meeting (2000 October)

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Collisional Evolution of Proto-Comets in the Solar Nebula During Ejection to the Oort Cloud: A Key Process

S. A. Stern[1], **P. R. Weissman**[2], **and D. D. Durda**[1]

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To appear in: 32nd Annual DPS meeting (2000 October)

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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`ekonews@boulder.swri.edu`