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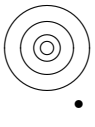
DISTANT EKOs



The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

ekonews@boulder.swri.edu www.boulder.swri.edu/ekonews

CONTENTS

NEWS & ANNOUNCEMENTS

There were 9 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2003 UA414, 2003 UZ413, 2004 NT33, 2004 PF115, 2004 PG115, 2004 XA192, 2005 CA79, 2005 CB79, 2005 UQ513

and 6 new Centaur/SDO discoveries:

2004 LR31, 2005 CC79, 2003 UY413, 2005 QU182, 2007 NC7, 2007 OC10

Reclassified objects:

2007 JG43 (Centaur → SDO)
2007 JG43 (SDO → Centaur)

Objects recently assigned numbers:

2000 OL67 = (160091)
2001 KN76 = (160147)
2001 KV76 = (160148)
2002 PD149 = (160256)
2005 RL43 = (160427)

Current number of TNOs: 1063 (including Pluto)
Current number of Centaurs/SDOs: 205
Current number of Neptune Trojans: 5

Out of a total of 1273 objects:

543 have measurements from only one opposition
505 of those have had no measurements for more than a year
268 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

Surface Composition of the Largest Dwarf Planet 136199 Eris (2003 UB_{313})

C. Dumas[1], F. Merlin[2], M.A. Barucci[2], C. de Bergh[2], O. Hainault[1], A. Guilbert[2], P. Vernazza[2], and A. Doressoundiram[2]

[1] ESO, Alonso de Cordova 3107, Vitacura, Casilla 19001, Santiago 19, Chile

[2] LESIA, Observatoire de Paris, 92195 Meudon Principal Cedex, France

Aims: The surface composition of the largest TNO, the dwarf planet 136199 Eris, is studied and compared to Pluto's.

Methods: High signal-to-noise visible and near-infrared reflectance spectra were obtained at the TNG and ESO-VLT observatories. The nature and properties of the compounds present on the surface of Eris are investigated by applying Hapke and Shkuratov radiative transfer models to our spectra.

Results: The surface of Eris can be modeled using two areas of distinct composition: about 50% appears to be covered with pure methane ice, while the rest of its surface would be made of an intimate mixture of methane, nitrogen and water ices, and ice tholin. The use of nitrogen in our model is shown to improve significantly the data fit, in particular for high surface albedo values. The icy grains are found to be large, from sub-mm to a few tens of mm in size.

Published in: Astronomy and Astrophysics, 471, 331 (2007 August)

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Ion Irradiation of TNO Surface Analogue Ice Mixtures: The Chemistry

G.A. Baratta[1], R. Brunetto[1,2], G. Caniglia[1], D. Fulvio[1], S. Ioppolo[1], G. Leto[1],M.E. Palumbo[1], F. Spinella[1], and G. Strazzulla[1]

[1] Istituto Nazionale di Astrofisica — Osservatorio Astrofisico di Catania, Via Santa Sofia78, I-95123 Catania, Italy

[2] Dipartimento di Fisica, Università degli Studi di Lecce, Via Arnesano, I-73100 Lecce, Italy

Vis-NIR spectra of some Centaurs and Trans-Neptunian Objects (TNOs) indicate surfaces rich in H_2O, N_2, CO_2, CH_4 and CH3OH. Cosmic ion irradiation is one of the processes driving the evolution of TNO surfaces. A main role is played by the chemistry induced by colliding ions; many molecular bonds are broken along the ion track, and this may lead to the formation of byproduct molecules. Starting from laboratory experiments, it is possible to infer the presence of molecules still undetected on TNOs. For instance, carbonic acid (H_2CO_3) is produced after irradiation of H_2O:CO_2 icy mixtures, while irradiation of H_2O:N_2 icy mixtures causes the production of N_2O, NO, and NO_2. From H_2O:CH_4:N_2 mixtures, many species are formed, such as CO, CO_2, HCN, HNCO, N_2O, and molecules including CN bonds. Moreover, ion irradiation may modify the relative intensity of NIR features, as in the case of solid methanol, whose 2.34 μm band decreases in intensity with respect to the 2.27 μm band, after increasing irradiation doses. We suggest that this effect may be observed on Centaur Pholus.

Published in: Memorie della Societa Astronomica Italiana Supplement, 11, 185

For preprints, contact gbaratta@oact.inaf.it

or on the web at http://sait.oat.ts.astro.it/MSAIS/11/PDF/185.pdf

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Near Infrared Spectra of Centaurs and Kuiper Belt Objects

K.M. Barkume[1], M.E. Brown [1], and E.L. Schaller[1]

[1] Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91101, USA

We present here an extensive survey of near infrared spectra of Kuiper belt objects (KBOs) and Centaurs taken with the Keck I Telescope. We find that most spectra in our sample are well characterized by a combination of water ice and a featureless continuum. A comparative analysis reveals that the near Infrared (NIR) spectral properties have little correlation to the visible colors or albedo, with the exception of the fragment KBOs produced from the giant impact on 2003 EL61. The results suggest that the surface composition of KBOs is heterogeneous, though the exposure of water ice may be controlled by geophysical processes. The Centaurs also display diverse spectral properties, but the source of the variability remains unclear. The results for both the KBOs and the Centaurs point to inherent heterogeneity in either the processes acting on these objects or materials from which they formed.

To appear in: The Astronomical Journal

Preprints available at `http://www.gps.caltech.edu/~barkume/publications.html`

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U-Band Photometry of Kuiper Belt Objects

D. Jewitt[1], N. Peixinho[2], and H. Hsieh[3]

[1] Institute for Astronomy, University of Hawaii, USA

[2] Astrophysics Group, University of Coimbra, Portugal

[3] Queen's University, Belfast, Northern Ireland, UK

We present U-band photometry of Kuiper Belt objects taken to further investigate their color-orbit systematics. As at longer optical and near-infrared wavelengths, the U-band colors of Kuiper Belt objects show a wide range and a unimodal distribution. We find no evidence that color systematics in the Kuiper belt are strongly wavelength dependent. This observation is consistent with control of the reflection characteristics by a single (but unidentified) reddening material. No evidence is found for blue/ultraviolet absorption that can arise from charge-transfer transitions in hydrated minerals in some primitive (C-type) asteroids. In the classical KBOs alone the $U - B$ and other color indices are most strongly correlated with the Tisserand parameter measured with respect to Neptune.

To appear in: The Astronomical Journal (2007 December)

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Candidate Members and Age Estimate of the Family of Kuiper Belt Object 2003 EL61

D. Ragozzine[1] and M.E. Brown[1]

[1] Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91101, USA

The collisional family of Kuiper belt object (KBO) 2003 EL61 opens the possibility for many interesting new studies of processes important in the formation and evolution of the outer solar system. As the first family in the Kuiper belt, it can be studied using techniques developed for studying asteroid families, although some modifications are necessary. Applying these modified techniques allows for a dynamical study of the 2003 EL61 family. The velocity required to change orbits is used to quantitatively identify objects near the collision. A method for identifying family members that have potentially diffused in resonances (like 2003 EL61) is also developed. Known family members are among the very closest KBOs to the collision and two new likely family members are identified: 2003 UZ117 and 1999 OY3. We also give tables of candidate family members which require future observations to confirm membership. We estimate that a minimum of $\sim$1 GYr is needed for resonance diffusion to produce the current position of 2003 EL61, implying that the family is likely primordial. Future refinement of the age estimate is possible once (many) more resonant objects are identified. The ancient nature of the collision contrasts with the seemingly fresh surfaces of known family members, suggesting that our understanding of outer solar system surfaces is incomplete.

To appear in: The Astronomical Journal
For preprints, contact `darin@gps.caltech.edu`
or on the web at `http://arxiv.org/abs/0709.0328`

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The Origin and Distribution of the Centaur Population

Romina P. Di Sisto[1] and Adrián Brunini[1]

[1] Facultad de Ciencias Astronómicas y Geofísicas (UNLP) and Instituto de Astrofísica de La Plata (CONICET) Paseo del Bosque s/n (1900) La Plata, Argentina

We analyze the Centaur population as a group of objects with perihelion distances (q) of less than 30 AU and heliocentric distances outside the orbit of Jupiter, formed by objects entering this region from the Scattered Disk (SD). We perform a numerical integration of 95 real scattered disk objects (SDOs) extracted from the Minor Planet Center database and of 905 synthetic SDOs compensating for observational biases. SDOs have in the Centaur zone a mean lifetime of 72 My, though this number falls with a decrease of q. After this incursion, 30% of them enter the zone interior to Jupiter's orbit. We find that the contribution to the Centaur population from the SD gives a total of $\sim 2.8 \times 10^8$ Centaurs with a radius $R > 1$ km. We also propose a model for the intrinsic distribution of orbital elements of Centaurs and their distance and apparent magnitude distribution.

Published in: Icarus, 190, 224 (2007 September)
For preprints, contact `romina@fcaglp.unlp.edu.ar`

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Testing Gravity in the Outer Solar System: Results from Trans-Neptunian Objects

John F. Wallin[1], David S. Dixon[2], and Gary L. Page[3]

[1] George Mason University, College of Science, Department of Computational and Data Sciences, Department of Physics and Astronomy, and Center for Earth Observing and Space Research (CEOSR), 4400 University Drive, MS 6A2, Fairfax, VA 22030, USA

[2] Jornada Observatory, Las Cruces, NM, USA

[3] George Mason University, College of Science, Department of Computational and Data Sciences, 4400 University Drive, MS 6A2, Fairfax, VA 22030, USA

The inverse square law of gravity is poorly probed by experimental tests at distances of ∼10 AUs. Recent analysis of the trajectory of the Pioneer 10 and 11 spacecraft have shown an unmodeled acceleration directed toward the Sun which was not explained by any obvious spacecraft systematics, and occurred when at distances greater than 20 AUs from the Sun. If this acceleration represents a departure from Newtonian gravity or is indicative of an additional mass distribution in the outer solar system, it should be detectable in the orbits of Trans-Neptunian Objects (TNOs). To place limits on deviations from Newtonian gravity, we have selected a well observed sample of TNOs found orbiting between 20 and 100 AU from the Sun. By examining their orbits with modified orbital fitting software, we place tight limits on the perturbations of gravity that could exist in this region of the solar system.

Published in: The Astrophysical Journal, 666, 1296 (2007 Sep 10)
For preprints, contact `jwallin@gmu.edu`
or on the web at `http://arxiv.org/abs/0705.3408`

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The Fundamental Role of the Oort Cloud in Determining the Flux of Comets through the Planetary System

V.V. Emel'yanenko[1], D.J. Asher[2], and M.E. Bailey[2]

[1] South Ural University, Chelyabinsk, 454080, Russia

[2] Armagh Observatory, College Hill, Armagh, BT61 9DG, U.K.

A model of the Oort cloud has been developed by accounting for planetary, stellar and Galactic perturbations using numerical symplectic integrations covering 4.5 Gyr. The model is consistent with the broad dynamical characteristics of the observed cometary populations injected from the Oort cloud into different regions of the Solar system. We show that the majority of observed high-eccentricity trans-Neptunian objects, Centaurs and short-period comets have visited the Oort cloud ($a > 1000$ AU) during their dynamical history. Assuming from observations that the near-parabolic flux from the Oort cloud with absolute magnitudes $H_{10} < 7$, perihelion distances $q < 5$ AU and $a > 10^4$ AU is approximately 1 comet per year, our calculations imply a present Oort cloud population of $\sim 5 \times 10^{11}$ comets with $H_{10} < 10.9$. Roughly half this number has $a > 10^4$ AU. The number of comets reaching the planetary region from the Oort cloud ($a > 1000$ AU) is more than an order of magnitude higher per unit perihelion distance immediately beyond Neptune than in the observable zone $q < 5$ AU. Similarly, the new-comet flux from the Oort cloud per unit perihelion distance is a few tens of times higher in the near-Neptune region than in the observable zone. The present number of high-eccentricity trans-Neptunian objects ($q > 30$ AU and $60 < a < 1000$ AU) originating from the Oort cloud is in the approximate range 1–3×10^{10}, depending on details of the initial model. A substantial fraction of these have $a > 200$ AU and/or $q > 40$ AU, and they are

found mostly to originate from initial orbits with $25 < q < 36$ AU. Similarly, the number of Centaurs produced from the Oort cloud, where we define Centaurs to have $5 < q < 28$ AU and $a < 1000$ AU, is smaller by a factor of 20–30. About 90 per cent of these Centaurs have $a > 60$ AU. Objects that have visited the Oort cloud represent a substantial fraction of the Jupiter-family comet population, achieving short-period orbits by a process of gradual dynamical transfer, including a Centaur stage, from the outer Solar system to near-Earth space. A similar mechanism produces Halley-type comets, in addition to the well-known diffusion process operating at small perihelion distances.

To appear in: Monthly Notices of the Royal Astronomical Society
Preprint on the web at `http://star.arm.ac.uk/preprints/2007/501.pdf`

BOOKS

Below is one more chapter that will appear in the "Kuiper Belt" book (M.A. Barucci, H. Boehnhardt,D. Cruikshank, and A. Morbidelli, eds.; U. Arizona Press, Tucson, 2007). Abstracts of other chapters were published in issues #51, #52, and #53 of this newsletter.

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The Early Development of Ideas Concerning the Trans-Neptunian Region

John K. Davies[1], John McFarland[2], Mark E. Bailey[2], Brian G. Marsdene[3], and Wing-Huen Ip[4]

[1] UK Astronomy Technology Centre, UK

[2] Armagh Observatory, UK

[3] Harvard-Smithsonian Center for Astrophysics, USA

[4] National Central University, Taiwan

We review the history of the prediction of, and searches for, a population of comets and trans-Neptunian planetesimals. Starting with initial speculations before and after the discovery of Pluto we examine various predictions by Edgeworth, Kuiper and others on the existence of such a population and review the increasingly sophisticated theoretical efforts which eventually showed that the number of short-period comets requires that an ecliptic trans-Neptunian population exists. We then recount various search programmes which culminated in the discovery of the first few trans-Neptunian objects and led to the realization that this region is dynamically much more complicated than at first suspected and has important links both to Centaurs and the dense inner core of the Oort cloud.

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

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:

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Moving ... ??

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