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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

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CONTENTS

NEWS & ANNOUNCEMENTS

In the "reports of my death have been greatly exaggerated" category, the canceled Pluto/Kuiper Express mission has been resurrected. The Announcement of Opportunity for the restructured Pluto-Kuiper Belt Mission is at: `http://spacescience.nasa.gov/ao/01-oss-01/draft/`.

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One of the recently-discovered TNOs, 2000 WR106, got a fair amount of popular press (e.g., `http://news.bbc.co.uk/hi/english/sci/tech/newsid_1054000/1054157.stm`) since it is apparently quite large. As reported on January 2nd in IAUC 7554, Jewitt and Aussel used submillimeter observations to estimate a diameter of 900 km, roughly the size of Charon and Ceres[†], making 2000 WR106 the largest TNO discovered to date (other than Charon's companion...). 2000 WR106 was also detected during a few earlier epochs on Palomar digitized sky survey images (MPEC 2000-Y45; `http://cfa-www.harvard.edu/mpec/K00/K00Y45.html`), and it now has a baseline of astrometry measurements back to 1954. This gives it the claim to another superlative as the object that has gone from discovery to being eligible for numbering in the shortest amount of time, about one month. The measurements from those earlier epochs establish that 2000 WR106 is a "classical" TNO (cubewano); the recent observations alone would not have been able to rule out a highly eccentric (scattered disk) orbit.

[†]Rather appropriate since January 1st was the bicentennial anniversary of the discovery of Ceres.

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The discovery rate continues to climb, with 146 objects discovered in 1999 and 158 objects discovered in 2000 (and a few more reports of discoveries likely to trickle in over the next month or so).

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There were 38 new TNO discoveries announced since the previous issue of the *Distant EKOs* Newsletter:

2000 SB331, 2000 SC331, 2000 SD331, 2000 SE331, 2000 SF331, 2000 SG331,
2000 SH331, 2000 SJ331, 2000 SK331, 2000 SL331, 2000 SO331, 2000 SP331,
2000 ST331, 2000 WK183, 2000 WL183, 2000 WM183, 2000 WN183, 2000 WO183,
2000 WR106, 2000 WT169, 2000 WV12, 2000 WW12, 2000 WX12, 2000 YA2,
2000 YB2, 2000 YC2, 2000 YD2, 2000 YE2, 2000 YF2, 2000 YG2, 2000 YH2,
2000 YU1, 2000 YV1, 2000 YW1, 2000 YX1, 2000 YY1, 2000 YZ1, 2000 YB29

and 8 new Centaur/SDO discoveries:

2000 SN331, 2000 SM331, 2000 SQ331, 2000 SR331, 2000 SS331, 2000 SU331,
1996 AR20, 1996 AS20

Reclassified objects:
2000 CQ105 (TNO $\rightarrow$ SDO)

Objects with new designations:
1994 VK8 (19255)
1996 SZ4 (19299)
1996 TO66 (19308)
1998 WH24 (19521)

Current number of TNOs: 366 (and Pluto & Charon)
Current number of Centaurs/SDOs: 64

EDITORIALS & SHORT ARTICLES

I had sent out a message asking if people still wanted the LaTeX file for each issue of the Newsletter, or if just a notice with a table of contents and a web address would be sufficient. Since a surprising number of people requested that I still send out the full LaTeX file, I will continue to do so (the pro-LaTeX faction beat out con-LaTeX faction by two votes, but the majority of votes didn't have a strong preference one way or the other; no hanging chads, no recount). However, for those of you who don't use the LaTeX file, note that the header of the file contains an ASCII version of the issue's table of contents and the web address showing the location of the HTML, PS, and PDF versions of the new issue (which can always be found at `http://www.boulder.swri.edu/ekonews/issues/`). In the future, if *Distant EKOs* begins to publish larger files (e.g., figures) that would be more cumbersome to include via e-mail, it may become completely web-based with just an e-mail reminder when each issue becomes available.

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PAPERS ACCEPTED TO JOURNALS

The Kuiper Belt and Olbers Paradox

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We investigate the constraints that Olbers Paradox, applied to the Zodiacal Background as measured from space, sets on outer solar system objects. If extended to very faint limits, $R \sim$ 40–50 mag, the steep optical number counts of Kuiper Belt objects (KBOs) at $R \lesssim$ 26 imply an infinitely bright night sky. Small KBOs with radii of $r \sim 1$ μm to $r \sim 1$ km must have a size distribution $n(r) \propto r^{-a}$, with $a \sim 3.4$ or smaller to satisfy the known limits on the sky-surface brightness at optical and far-infrared wavelengths. Improved limits on the measured KBO surface brightness can yield direct estimates of the albedo, temperature, and size distribution for small KBOs in the outer solar system.

To appear in: The Astrophysical Journal Letters (10 January 2001)
Preprints available on the web at `http://cfa-www.harvard.edu/~kenyon/preprints.html`

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The Evolution of Bodies Orbiting in the Trans-Neptunian Region on to Intermediate-type Orbits

M.D. Maran[1] **and I.P. Williams**[1]

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We investigate the dynamical evolution of 210 hypothetical massless bodies initially situated between 10 and 30 AU from the Sun in order to determine the general characteristics of the evolved system. This is of particular relevance to the understanding of the origin of Edgeworth-Kuiper belt objects on scattered intermediate orbits, such as 1996 TL_{66}, which have high eccentricity and semimajor axis but nevertheless have perihelion in the region between 30 and 50 AU from the Sun.

Published in: Monthly Notices of the Royal Astronomical Society, 318, 482
For preprints, contact `i.p.williams@qmw.ac.uk`

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Mean Motion Resonances in the Trans-Neptunian Region. Part I: The 2:3 Resonance with Neptune

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The stability of the 2:3 mean motion resonance with Neptune is systematically explored and compared to the observed resonant population. It is shown that orbits with small and moderate amplitudes of the resonant angle are stable over the age of the Solar System. The observed resonant population is distributed within the stability limits. There exists an interval of large resonant amplitudes, where orbits are marginally unstable. Resonant objects starting in this interval may leave the resonance by slow increase of their resonant amplitudes on a time scale of several billion years. These objects eventually attain Neptune–crossing trajectories and contribute to the flux of Jupiter–family comets. The number of objects leaking from the 2:3 resonance per time interval is calibrated by the number of objects needed to keep the Jupiter–family comets population in steady state. This allows us to compute the upper limit of the number of resonant objects with cometary size. The effects of collisions and mutual gravitational scattering are discussed in this context.

Published in: Icarus, 148, 282 (2000 November)

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Mean Motion Resonances in the Trans-Neptunian Region. Part II: The 1:2, 3:4, and Weaker Resonances

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The stability of orbits in the trans–Neptunian region is numerically computed. It is found that, in analogy to the asteroid belt, there exist many chaotic layers at places of thin mean motion resonances. These are either moderate– and high–order resonances with Neptune or three–body resonances with Neptune and Uranus. The orbital eccentricity chaotically increases at the thin resonances allowing some Kuiper Belt Objects (KBOs) to be slowly transferred to Neptune–crossing orbits. The stability of two large mean motion resonances with Neptune — 1:2 and 3:4 — is systematically explored. It is shown that in both resonances, the orbits with small resonant amplitudes are stable over the age of the Solar System. The possible role of collisions and dynamical scattering in clearing the resonances is discussed. It is inferred from orbital angles of 1997 SZ10 and 1996 TR66 that these bodies are most probably on tadpole orbits in the 1:2 Neptune resonance.

To appear in: Icarus

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Extremely Red Kuiper-Belt Objects In Near-Circular Orbits Beyond 40 AU

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[2] Department of Physics & Astronomy, University of Oklahoma, Norman, OK, 73019, USA

Kuiper belt objects (KBOs) are an ancient reservoir of comets beyond Neptune's orbit. Some of these objects were recently found to have the reddest optical colours in the Solar System, but the number of objects for which accurate colours were available was too small for any correlation to be discerned between colour and physical or dynamical properties, which might shed light on the origin of these objects. Here we report that all nine of the KBOs in our survey on near-circular (low eccentricity) orbits with perihelion distances larger than 40 AU have extremely red surfaces, thereby connecting an observable property with a dynamical class. Of the objects with orbital eccentricities greater than 0.1, about half are also very red, while the rest have colours similar to the Sun, meaning that reflected sunlight is not strongly modified by the objects' surface properties. In addition, of the 13 'classical' KBOs (those with semi-major axes a $\sim$ 45 AU and eccentricity $e < 0.15$), the ten that are very red are in orbits with small angles of inclination to the ecliptic, whereas the three with solar colours are all in high-inclination orbits. We suggest that these three 'grey' classical KBOs may be part of a dynamical group that is separate from the 'red' classical KBOs.

Published in: Nature, 407, 979 (2000 October 26)

For reprints, contact `Stephen.Tegler@nau.edu`

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On the Size-Dependence of the Inclination Distribution of the Main Kuiper Belt

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We present a new analysis of the currently available orbital elements for the known Kuiper belt objects. In the non-resonant, main Kuiper belt we find a statistically significant relationship between an object's absolute magnitude (H) and its inclination (i). Objects with $H < 6.5$ (i.e. radii $\gtrsim$ 170km for a 4% albedo) have higher inclinations than those with $H > 6.5$ (radii $\lesssim$ 170 km). We have shown that this relationship is not caused by any obvious observational bias. We argue that the main Kuiper belt consists of the superposition of two distinct distributions. One is dynamically hot with inclinations as large as $\sim 35^\circ$ and absolute magnitudes as bright as 4.5; the other is dynamically cold with $i \lesssim 5^\circ$ and $H > 6.5$. The dynamically cold population is most likely dynamically primordial. We speculate on the potential causes of this relationship.

To appear in: The Astronomical Journal

For preprints, contact `hal@gort.boulder.swri.edu`
or on the web at `http://www.boulder.swri.edu/~hal/papers.html`

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Constraints on the Birth Aggregate of the Solar System

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Using the observed properties of our solar system, in particular the isotopic compositions of meteorites and the regularity of the planetary orbits, we constrain the star formation environment of the Sun within the scenario of (external) radioactive enrichment by a massive star. This calculation yields a probability distribution for the number of stars in the solar birth aggregate. The Sun is most likely to have formed within a stellar group containing $N = \langle N \rangle \approx 2000 \pm 1100$ members. The *a priori* probability of a star forming in this type of environment is $\mathcal{P} \approx 0.0085$, i.e., only about 1 out of 120 solar systems are expected to form under similar conditions. We discuss additional implications of this scenario, including possible effects from the radiation fields provided by the putative cluster environment and dynamical disruption of the Kuiper Belt. The constraints of this paper place tight restrictions on the properties of the solar birth aggregate for the scenario of external enrichment by a massive star; alternately, these tight constraints slightly favor a self-enrichment scenario for the short-lived radioactive species.

To appear in: Icarus

For preprints, contact `fca@umich.edu`

or on the web at `http://www.arXiv.org/abs/astro-ph/0011326`

PAPERS RECENTLY SUBMITTED TO JOURNALS

The Rotation Axis of the Centaur 5145 Pholus

Tony L. Farnham[1]

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Submitted to: Icarus

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Upper Limits on Gaseous CO at Pluto and Triton from High-Resolution Near-IR Spectroscopy

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Submitted to: Icarus

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or on the web at http://www.boulder.swri.edu/~layoung/eprint/COupperlim/

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UV Observations of Triton in 1999 with HST/STIS: 2150–3180 Å Spectroscopy and Disk-Integrated Photometry

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Submitted to: The Astronomical Journal

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or on the web at http://www.boulder.swri.edu/~layoung/eprint/TritonSTIS_99/

OTHER PAPERS OF INTEREST

The Lightcurve and Colors of Unusual Minor Planet 1998 WU_{24}

John K. Davies[1], **David J. Tholen**[2], **Robert J. Whiteley**[2],
Simon F. Green[3], **Jon K. Hillier**[4], **Michael J. Foster**[4],
Neil McBride[3], **Tom. H Kerr**[1], **and Erica Muzzerall**[1]

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To appear in: Icarus

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or on the web linked from http://www.jach.hawaii.edu/~jkd/cv.html

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JOB ANNOUNCEMENTS

Postdoc Position

National Central University, Taiwan

National Central University is undertaking an EKO occultation survey program, in collaboration with Lawrence Livermore National Laboratory (USA), Academia Sinica (Taiwan), and other institutes. The Taiwan-America Occultation Survey (TAOS) aims to set up an array of small telescopes in Taiwan to monitor chance stellar occultation events by EKOs. Applications are invited for a postdoc position to work on this project. The successful applicant shall work in Taiwan, to spend half of the time on his/her own research, and the other half helping out hardware and software development, data analysis, and scientific interpretation specifically to this project. Application should include a CV with publication list, a statement for research plan, and three names from whom reference letters can be request. Applications received by 31 January 2001 will receive full consideration. Inquires and applications should sent to:

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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`

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`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 EKOs 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 EKOs* 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`