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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

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NEWS & ANNOUNCEMENTS

Centaur 60558 Echeclus (= 2000 EC98 = comet 174P/Echeclus) appears to have split or experienced some such event that has caused a detached cometary feature.
http://www.newscientistspace.com/article/dn8976-hybrid-cometasteroid-in-mysterious-breakup.ht
http://observatory.ou.edu/
IAUCs: http://cfa-www.harvard.edu/iauc/08600/08656.html,
http://cfa-www.harvard.edu/iauc/08600/08660.html,
http://cfa-www.harvard.edu/iauc/08600/08677.html,
http://cfa-www.harvard.edu/iauc/08700/08701.html, et al.

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In IAUC 8689, Keith Noll and collaborators announced the discovery of a satellite around the SDO 2000 CM114 (the same IAU Circular reports the binarity of 2002 CR46, which was reported earlier in a CBET and in last month's issue of the Newsletter). The satellite was 0.5 mag fainter than the primary and at a separation of 0.073 arcsec.
IAUC: http://cfa-www.harvard.edu/iauc/08600/08689.html

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Hubble observations of 2003 UB313 ("Xena") By Mike Brown and collaborators give diameter comparable to Pluto (see article in this issue).
http://www.nasa.gov/mission_pages/hubble/hst_xena_20060410.html
This is smaller than previously thought, implying that it has a very high albedo of ∼86%. The difference between the HST and ground-based thermal emission measurements may be consistent within their uncertainties:
http://www.astro.uni-bonn.de/~bertoldi/ub313/

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MPECs 2006-H29, H30, and H35 published the first batch of TNOs discovered by the Canada France Ecliptic Plane Survey (CFEPS) to be submitted to the Minor Planet Center, consisting of 45 new objects with well-defined orbits from three-year arcs, 12 new one-opposition objects, and several recovery and multi-opposition measurements of objects already in the MPC database.
http://www.newscientistspace.com/article/dn9056.html
http://www.cfeps.astrosci.ca/
MPECs: http://cfa-www.harvard.edu/cfa/ps/mpec/K06/K06H29.html,
http://cfa-www.harvard.edu/cfa/ps/mpec/K06/K06H30.html,
http://cfa-www.harvard.edu/cfa/ps/mpec/K06/K06H35.html

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The New Horizons mission team notes that the New Horizons spacecraft will transit the trailing Neptune Trojan zone in 2014, the year prior to their Pluto system encounter in 2015. In addition to making dust impact rate measurements during this transit, there is interest in the possibility of observing a Neptunian Trojan to obtain a phase curve or even a close flyby if a suitable candidate can be found. Observing teams interested in conducting searches for suitable Neptune Trojans and participating in observations using New Horizons in 2014 should contact New Horizons mission PI Alan Stern. See the figure at: http://www.boulder.swri.edu/ekonews/issues/past/n046/Neptune_Trojans.jpg

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There were 58 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2005 PD23, 2005 PE23, 2005 PF23, 2005 PG23, 2005 PH23, 2002 WL21, 2003 FA130, 2003 HA57, 2003 HC57, 2003 HD57, 2003 HE57, 2003 HF57, 2003 HG57, 2003 HH57, 2003 HX56, 2003 HY56, 2003 HZ56, 2003 QX113, 2003 SN317, 2003 SO317, 2003 SP317, 2003 SQ317, 2003 SR317, 2003 SS317, 2003 TG58, 2003 TH58, 2003 TJ58, 2003 TK58, 2003 TL58, 2003 YJ179, 2003 YK179, 2003 YL179, 2003 YM179, 2003 YN179, 2003 YO179, 2003 YP179, 2003 YR179, 2003 YS179, 2003 YT179, 2003 YU179, 2003 YV179, 2003 YW179, 2003 YX179, 2004 FW164, 2004 XX190, 2005 TV189, 2003 FB130, 2003 HJ57, 2003 HK57, 2003 HL57, 2003 HM57, 2003 HN57, 2003 HO57, 2003 HP57, 2003 QY113, 2003 QZ113, 2003 YY179, 2003 YZ179

and 5 new Centaur/SDO discoveries:

2006 AA99, 2003 FZ129, 2003 HB57, 2003 QW113, 2003 YQ179

Reclassified objects:

2005 TN74 (NTrojan → SDO)
2001 XH255 (SDO → TNO)

Objects recently assigned numbers:

1999 XX143 = (121725)
2002 CX154 = (126619)
2002 XU93 = (127546)
2000 WK183 = (123509)
2001 YH140 = (126154)
2001 YJ140 = (126155)
2002 CC249 = (126719)
2003 FC128 = (127871)

Current number of TNOs: 990 (including Pluto)
Current number of Centaurs/SDOs: 166
Current number of Neptune Trojans: 4
Current number of satellites: 21 around 17 objects

Out of a total of 1160 objects:

513 have measurements from only one opposition
466 of those have had no measurements for more than a year
239 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

Kuiper Belt and Comets: An Observational Perspective

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These notes outline a series of lectures given at the Saas Fee Winter School held in Murren, Switzerland, in March 2005. As I see it, the main aim of the Winter School is to communicate (especially) with young people in order to inflame their interests in science and to encourage them to see ways in which they can contribute and maybe do a better job than we have done so far. With this in mind, I have written up my lectures in a less than formal but hopefully informative and entertaining style, and I have taken a few detours to discuss subjects that I think are important but which are usually glossed-over in the scientific literature.

To appear in: "Trans-Neptunian Objects and Comets," 35th Saas Fee Advanced Course of the Swiss Society for Astrophysics and Astronomy (eds. N. Thomas, W. Benz and K. Altwegg), Springer Pub. Co.

Preprints available on the web at

`http://www.ifa.hawaii.edu/faculty/jewitt/papers/2006/J06b.pdf`

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On the Orbits and Masses of the Satellites of the Pluto-Charon System

Man Hoi Lee[1] **and S. J. Peale**[1]

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Two small satellites of Pluto, S/2005 P1 (hereafter P1) and S/2005 P2 (hereafter P2), have recently been discovered outside the orbit of Charon, and their orbits are nearly circular and nearly coplanar with that of Charon. Because the mass ratio of Charon-Pluto is ~ 0.1, the orbits of P2 and P1 are significantly non-Keplerian even if P2 and P1 have negligible masses. We present an analytic theory, with P2 and P1 treated as test particles, which shows that the motion can be represented by the superposition of the circular motion of a guiding center, the forced oscillations due to the non-axisymmetric components of the potential rotating at the mean motion of Pluto-Charon, the epicyclic motion, and the vertical motion. The analytic theory shows that the azimuthal periods of P2 and P1 are shorter than the Keplerian orbital periods, and this deviation from Kepler's third law is already detected in the unperturbed Keplerian fit of Buie and coworkers. In this analytic theory, the periapse and ascending node of each of the small satellites precess at nearly equal rates in opposite directions.

From direct numerical orbit integrations, we show the increasing influence of the proximity of P2 and P1 to the 3:2 mean-motion commensurability on their orbital motion as their masses increase within the ranges allowed by the albedo uncertainties. If the geometric albedos of P2 and P1 are high and of order of that of Charon, the masses of P2 and P1 are sufficiently low that their orbits are well described by the analytic theory. The variation in the orbital radius of P2 due to the forced oscillations is comparable in magnitude to that due to the best-fit Keplerian eccentricity, and there is at present no evidence that P2 has any significant epicyclic eccentricity. However, the orbit of P1 has a significant epicyclic eccentricity, and the prograde precession of its longitude of periapse with a period of 5300 days should be easily detectable. If the albedos of P2 and P1 are as low as

that of comets, the large inferred masses induce significant short-term variations in the epicyclic eccentricities and/or periapse longitudes on the 400–500-day timescales due to the proximity to the 3:2 commensurability. In fact, for the maximum inferred masses, P2 and P1 may be in the 3:2 mean-motion resonance, with the resonance variable involving the periapse longitude of P1 librating. Observations that sample the orbits of P2 and P1 well on the 400–500-day timescales should provide strong constraints on the masses of P2 and P1 in the near future.

To appear in: Icarus
Preprints available on the web at `http://arxiv.org/abs/astro-ph/0603214`

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New Constraints on Additional Satellites of the Pluto System

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Observations of Pluto and its solar-tidal stability zone were made using the Advanced Camera for Surveys' (ACS) Wide Field Channel (WFC) on the *Hubble Space Telescope* on UT 2005 May 15 and UT 2005 May 18. Two small satellites of Pluto, provisionally designated S/2005 P 1 and S/2005 P 2, were discovered, as discussed by Weaver et al. (2006) and Stern et al. (2006). Confirming observations of the newly discovered moons were obtained using the ACS in the High Resolution Channel (HRC) mode on 2006 Feb 15 Mutchler et al. (2006). Both sets of observations provide strong constraints on the existence of any additional satellites in the Pluto system. Based on the May 2005 observations using the ACS/WFC, we place a 90%-confidence lower limit of $m_V = 26.8$ ($m_V = 27.4$ for a 50%-confidence lower limit) on the magnitude of undiscovered satellites greater than 5 arcsec (1.1×10^5 km) from Pluto. Using the 2005 Feb 15 ACS/HRC observations we place 90%-confidence lower limits on the apparent magnitude of any additional satellites of $m_V = 26.4$ between 3–5 arcsec (6.9×10^4–1.1×10^5 km) from Pluto, $m_V = 25.7$ between 1–3 arcsec (2.3×10^4–6.9×10^4 km) from Pluto, and $m_V = 24.$ between 0.3–1 arcsec (6.9×10^3–2.3×10^4 km) from Pluto. The 90%-confidence magnitude limits translate into upper limits on the diameters of undiscovered satellites of 29 km outside of 5 arcsec from Pluto, 36 km between 3–5 arcsec from Pluto, 49 km between 1–3 arcsec from Pluto, and 115 km between 0.3–1 arcsec for a comet-like albedo of $p_V = 0.04$. If potential satellites are assumed to have a Charon-like albedo of $p_V = 0.38$, the diameter limits are 9 km, 12 km, 16 km, and 37 km, respectively.

To appear in: The Astronomical Journal
For preprints, contact `steffl@boulder.swri.edu`
or on the web at `http://arxiv.org/abs/astro-ph/0511837`

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The Dynamics of Objects in the Inner Edgeworth-Kuiper Belt

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Objects in 3:2 mean motion resonance with Neptune are protected from close encounters with Neptune by the resonance. Bodies in orbits with semi-major axis between 39.5 and about 42 AU are not protected by the resonance; indeed due to overlapping secular resonances, the eccentricities of orbits in this region are driven up so that a close encounter with Neptune becomes inevitable. It is thus expected that such orbits are unstable. The list of known Trans-Neptunian objects shows a deficiency in the number of objects in this gap compared to the 43–50 AU region, but the gap is not empty. We numerically integrate models for the initial population in the gap, and also all known objects over the age of the Solar System to determine what fraction can survive. We find that this fraction is significantly less than the ratio of the population in the gap to that in the main belt, suggesting that some mechanism must exist to introduce new members into the gap. By looking at the evolution of the test body orbits, we also determine the manner in which they are lost. Though all have close encounters with Neptune, in most cases this does not lead to ejection from the Solar System, but rather to a reduced perihelion distance causing close encounters with some or all of the other giant planets before being eventually lost from the system, with Saturn appearing to be the cause of the ejection of most of the objects.

To appear in: Earth, Moon, and Planets
Preprints on the web at `http://dx.doi.org/10.1007/s11038-006-9069-7`

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Direct Measurement of the Size of 2003 UB313 from the Hubble Space Telescope

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We have used the Hubble Space Telescope to directly measure the angular size of the large Kuiper belt object 2003 UB313. By carefully calibrating the point spread function of a nearby field star, we measure the size of 2003 UB313 to be 34.3±1.4 milliarcseconds, corresponding to a diameter of 2400±100 km or a size $\sim 5\%$ larger than Pluto. The V band geometric albedo of 2003 UB313 is $86 \pm 7\%$. The extremely high albedo is consistent with the frosty methane spectrum, the lack of red coloring, and the lack of observed photometric variation on the surface of 2003 UB313. Methane photolysis should quickly darken the surface of 2003 UB313, but continuous evaporation and redeposition of surface ices appears capable of maintaining the extreme alebdo of this body.

To appear in: The Astrophysical Journal Letters
Preprints available on the web at `http://arxiv.org/abs/astro-ph/0604245`

PAPERS RECENTLY SUBMITTED TO JOURNALS

The Positions, Colors, and Photometric Variability of Pluto's Small Satellites from HST Observations 2005-2006

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Submitted to: The Astronomical Journal

Preprints on the web at `http://arxiv.org/abs/astro-ph/0605014`

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The Dust Coma of the Active Centaur P/2004 A1 (LONEOS): A CO–driven Environment?

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Submitted to: Astronomy & Astrophysics

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Charon's Radius and Density from the Combined Data Sets of the 2005 July 11 Occultation

M.J. Person[1], J.L. Elliot[1,2,3], A.A.S. Gulbis[1], J.M. Pasachoff[4], B.A. Babcock[5], S.P. Souza[4], and J. Gangestad[4]

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Submitted to: The Astronomical Journal

Preprints available on the web at `http://arxiv.org/abs/astro-ph/0602082`

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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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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