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*DISTANT EKOs*  
*The Kuiper Belt Electronic Newsletter*



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# NEWS & ANNOUNCEMENTS

Of course, big objects are the big news. Three large objects are reported by Brown et al. and Santos-Sanz et al. in:

IAUC 8577: <http://cfa-www.harvard.edu/iauc/08500/08577.html>

MPEC 2005 O36: <http://cfa-www.harvard.edu/cfa/ps/mpec/K05/K05036.html>

MPEC 2005 O41: <http://cfa-www.harvard.edu/cfa/ps/mpec/K05/K05041.html>

MPEC 2005 O42: <http://cfa-www.harvard.edu/cfa/ps/mpec/K05/K05042.html>

The objects and their absolute magnitudes are

2003 EL61:  $H = 0.4$

2005 FY9:  $H = 0.1$

2003 UB313:  $H = -1.1$

For comparison, Pluto has  $H = -1.0$ .

How big are they? That depends on their albedo; measurements of TNO albedos indicate that they may generally be slightly higher than the canonical assumed value of 0.04. Pluto has a comparatively high albedo ( $\gtrsim 0.50$ ). Below is the diameter (in km) as a function of albedo from the table at <http://cfa-www.harvard.edu/iau/lists/Sizes.html>:

$H$	Albedo		
	0.50	0.25	0.05
-1.5	3700	5300	11800
-1.0	3000	4200	9400
-0.5	2400	3300	7500
0.0	1900	2600	5900
0.5	1500	2100	4700

Additional information and comments on the discovery of 2005 UB313 can be found on the discoverer's website at:

<http://www.gps.caltech.edu/~mbrown/planetlila/>

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IAUC 8577 also reports the discovery by Brown et al. that 2003 EL61 is a binary, with a period of  $P \sim 49.1$  days, a semimajor axis of  $a \sim 49500$  km, and a total system mass about a third of the mass of the Pluto-Charon system. Details are given in the paper listed in this issue of the Newsletter.

The list of known binary TNOs is at:

<http://www.boulder.swri.edu/ekonews/objects/binaries.html>

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In MPEC 2005 L33, Marsen and Buie et al. identify 2003 LG7 as first object discovered to be in the 1:3 resonance with Neptune.

MPEC 2005 L33: <http://cfa-www.harvard.edu/cfa/ps/mpec/K05/K05L33.html>

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The stellar occultation by Charon was the target of an observing campaign reported in IAUC 8570. The results reported by L.A. Young et al. give a lower limit on Charon's diameter of  $1179 \pm 4$  km, and no detection of an atmosphere.

IAUC 8570: <http://cfa-www.harvard.edu/iauc/08500/08570.html>

Teams from MIT, Williams College, Southwest Research Institute, and the Observatory of Paris at Meudon observed the event. This MIT press release shows a movie of the event:

<http://web.mit.edu/newsoffice/2005/charon.html>

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Romanishin and Tegler report in IAUC 8545 the detection of a faint coma around the Centaur 2004 PY42.

IAUC 8545: <http://cfa-www.harvard.edu/iauc/08500/08545.html>

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Several days after the above announcement of cometary activity in Centaur 2004 PY42, IAUC 8552 presented an editorial from the Minor Planet Center about the difficulty in having consistent nomenclature rules for cometary Centaurs and TNOs, not only for the numbering scheme, but also for the names (mythical creatures vs. the discoverers; typically the two do not overlap). A hybrid solution will be followed: rather than use the cometary rules for numbering (observations at two or more perihelion passages, which would be unwieldy for Centaurs), the MPC will continue to use the criteria used for Centaurs and TNOs, i.e., a well-known orbit (MPC orbit uncertainty parameter  $\leq 3$ ) and observations during four or more oppositions (with at least one recent). The object's name will be that of the discoverer(s), following the convention for comets. Also, note that such objects will no longer appear in the MPC's Distant Object databases, but will be moved to the comet databases.

IAUC 8552: <http://cfa-www.harvard.edu/iauc/08500/08552.html>

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There were 18 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2005 JH177, 2005 GV210, 2005 GW210, 2005 JO179, 2005 JP179, 2005 JQ179,  
2005 JR179, 2004 US10, 2004 UT10, 2004 UU10, 2004 XW186, 2004 XX186,  
2004 XY186, 2004 XZ186, 2003 EL61, 2005 FY9, 2003 OP32, 2004 TY364

and 1 new SDO discovery:

2003 UB313

Reclassified objects:

2005 EB299 (TNO  $\rightarrow$  SDO)  
2005 EF304 (TNO  $\rightarrow$  SDO)  
2003 QK91 (TNO  $\rightarrow$  SDO)  
2005 EZ300 (SDO  $\rightarrow$  TNO)

Objects recently assigned numbers:

2000 EC98 = (60558)

Deleted/Re-identified objects:

2004 NE32 = 2002 GE32  
2004 PY42 = 167P/2004 PY42 (CINEOS) [deleted from list of Centaurs and moved to list of comets]

Current number of TNOs: 901 (and Pluto & Charon, and 13 other TNO binary companions)

Current number of Centaurs/SDOs: 154

Current number of Neptune Trojans: 2

Out of a total of 1056 objects:

507 have measurements from only one opposition

409 of those have had no measurements for more than a year

205 of those have arcs shorter than 10 days

(for more details, see: [http://www.boulder.swri.edu/ekonews/objects/recov\\_stats.gif](http://www.boulder.swri.edu/ekonews/objects/recov_stats.gif))

## Neptune's Migration into a Stirred-Up Kuiper Belt: A Detailed Comparison of Simulations to Observations

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N-body simulations are used to examine the consequences of Neptune's outward migration into the Kuiper Belt, with the simulated endstates being compared rigorously and quantitatively to the observations. These simulations confirm the findings of Chiang et al. (2003), who showed that Neptune's migration into a previously stirred-up Kuiper Belt can account for the Kuiper Belt Objects (KBOs) known to librate at Neptune's 5:2 resonance. We also find that capture is possible at many other weak, high-order mean motion resonances, such as the 11:6, 13:7, 13:6, 9:4, 7:3, 12:5, 8:3, 3:1, 7:2, and the 4:1. The more distant of these resonances, such as the 9:4, 7:3, 5:2, and the 3:1, can also capture particles in stable, eccentric orbits beyond 50 AU, in the region of phase space conventionally known as the Scattered Disk. Indeed, 90% of the simulated particles that persist over the age of the Solar System in the so-called Scattered Disk zone never had a close encounter with Neptune, but instead were promoted into these eccentric orbits by Neptune's resonances during the migration epoch. This indicates that the observed Scattered Disk might not be so scattered. This model also produced only a handful of Centaurs, all of which originated at Neptune's mean motion resonances in the Kuiper Belt. However a noteworthy deficiency of the migration model considered here is that it does not account for the observed abundance of Main Belt KBOs having inclinations higher than 15 degrees.

In order to rigorously compare the model endstate with the observed Kuiper Belt in a manner that accounts for telescopic selection effects, Monte Carlo methods are used to assign sizes and magnitudes to the simulated particles that survive over the age of the Solar System. If the model considered here is indeed representative of the outer Solar System's early history, then the following conclusions are obtained: (i) the observed 3:2 and 2:1 resonant populations are both depleted by a factor of  $\sim 20$  relative to model expectations; this depletion is likely due to unmodeled effects, possibly perturbations by other large planetesimals, (ii) the size distribution of those KBOs inhabiting the 3:2 resonance is significantly shallower than the Main Belt's size distribution, (iii) the total number of KBOs having radii  $R > 50$  km and orbiting interior to Neptune's 2:1 resonance is  $N \sim 1.7 \times 10^5$ ; these bodies have a total mass of  $M \sim 0.08(\rho/1 \text{ gm/cm}^3)(p/0.04)^{-3/2}$  Earth-masses assuming they have a material density  $\rho$  and an albedo  $p$ . We also report estimates of the abundances and masses of the Belt's various subpopulations (e.g., the resonant KBOs, the Main Belt, and the so-called Scattered Disk), and also provide upper limits on the abundance of Centaurs and Neptune's Trojans, as well as upper limits on the sizes and abundances of hypothetical KBOs that might inhabit the  $a > 50$  AU zone.

**To appear in: The Astronomical Journal**

*Preprint on the web at*    <http://apwww.stmarys.ca/~jhahn/pubs/migrate.pdf>

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# Centaurs from the Oort Cloud and the Origin of Jupiter-family Comets

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A numerical study of an ensemble of orbits based on observed objects in the near-Neptune high-eccentricity (NNHE) region, with perihelion distances  $q$  in the range  $28 < q < 35.5$  AU and semimajor axes  $a$  in the range  $60 < a < 1000$  AU, is used to predict the orbital distribution of Centaurs ( $5 < q < 28$  AU) for comparison with observations after correcting for discovery biases. The majority of Centaurs produced in this way have  $a \lesssim 60$  AU. However, the intrinsic number of observed Centaurs is dominated by longer period objects, the number with  $a > 60$  AU being roughly an order of magnitude greater than that for  $a < 60$  AU, and therefore inconsistent with a source in the NNHE region, which is broadly similar to the so-called 'Scattered Disc'. The observed distribution of Centaurs with  $a \lesssim 60$  AU is also inconsistent with this source, although it is conceivable that in this region the discrepancies might be explained by factors such as outgassing, splitting or varying albedo not included in our model. Thus, although Centaurs can be produced from the NNHE region, their numbers and orbital distributions are inconsistent with this region being the dominant source for all Centaurs. We conclude that there must be another source flux, especially for the longer period, more populous group, and suggest that the most likely source for these objects is the Oort cloud. Thus, there are two separate, but overlapping dynamical classes of Centaurs, one originating from the Oort cloud and the other from the NNHE region. The two source regions produce roughly similar contributions to Centaurs with  $a \lesssim 60$  AU and to the observed Jupiter family of comets.

**To appear in: Monthly Notices of the Royal Astronomical Society**

*Preprint on the web at* <http://star.arm.ac.uk/preprints/>

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## Escape from Planetary Neighbourhoods

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In this paper we use recently developed phase-space transport theory coupled with a so-called classical spectral theorem to develop a dynamically exact and computationally efficient procedure for studying escape from a planetary neighbourhood. The 'planetary neighbourhood' is a bounded region of phase space where entrance and escape are only possible by entering or exiting narrow 'bottlenecks' created by the influence of a saddle point. The method therefore immediately applies to, for example, the circular restricted three-body problem and Hill's lunar problem (which we use to illustrate the results), but it also applies to more complex, and higher-dimensional, systems possessing the relevant phase-space structure. It is shown how one can efficiently compute the mean passage time through the planetary neighbourhood, the phase-space flux in, and out, of the planetary neighbourhood, the phase-space volume of initial conditions corresponding to trajectories that escape from the planetary neighbourhood, and the fraction of initial conditions in the planetary neighbourhood corresponding to bound trajectories. These quantities are computed for Hill's problem. We study the dependence of the proportions of these quantities on energy and dimensionality (two-dimensional planar and three-dimensional spatial Hill's problem). The methods and quantities presented are of central interest for many celestial and stellar dynamical applications such as, for example, the capture and escape of

moons near giant planets, the formation of binaries in the Kuiper belt and the escape of stars from star clusters orbiting about a galaxy.

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## Formation of Kuiper-belt Binaries Through Multiple Chaotic Scattering Encounters with Low-mass Intruders

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The discovery that many trans-Neptunian objects exist in pairs, or binaries, is proving invaluable for shedding light on the formation, evolution and structure of the outer Solar system. Based on recent systematic searches it has been estimated that up to 10 per cent of Kuiper-belt objects might be binaries. However, all examples discovered to date are unusual, as compared with near-Earth and main-belt asteroid binaries, for their mass ratios of the order of unity and their large, eccentric orbits. In this article we propose a common dynamical origin for these compositional and orbital properties based on four-body simulations in the Hill approximation. Our calculations suggest that binaries are produced through the following chain of events. Initially, long-lived quasi-bound binaries form by two bodies getting entangled in thin layers of dynamical chaos produced by solar tides within the Hill sphere. Next, energy transfer through gravitational scattering with a low-mass intruder nudges the binary into a nearby non-chaotic, stable zone of phase space. Finally, the binary hardens (loses energy) through a series of relatively gentle gravitational scattering encounters with further intruders. This produces binary orbits that are well fitted by Kepler ellipses. Dynamically, the overall process is strongly favoured if the original quasi-bound binary contains comparable masses. We propose a simplified model of chaotic scattering to explain these results. Our findings suggest that the observed preference for roughly equal-mass ratio binaries is probably a real effect; that is, it is not primarily due to an observational bias for widely separated, comparably bright objects. Nevertheless, we predict that a sizeable population of very unequal-mass Kuiper-belt binaries is probably awaiting discovery.

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*Preprints available on the web at:* <http://arxiv.org/abs/astro-ph/0504060>

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## Is Sedna Another Triton?

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90377 Sedna is, so far, the largest and most distant trans-neptunian object. It was observed at visible and near-infrared wavelengths using simultaneously two 8.2 m telescopes at the Very Large

Telescope of the European Southern Observatory. The spectrum of Sedna suggests the presence on its surface of different ices (total abundance  $> 50\%$ ). Its surface composition is different from that determined for other trans-neptunian objects, and apparently resembles that of Triton, particularly in terms of the possible presence of nitrogen and methane ices.

**To appear in: Astronomy and Astrophysics**

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## On the Rotation Period of (90377) Sedna

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We present precise,  $\sim 1\%$ ,  $r$ -band relative photometry of the unusual solar system object (90377) Sedna. Our data consist of 143 data points taken over eight nights in October 2004 and January 2005. The RMS variability over the longest contiguous stretch of five nights of data spanning nine days is only  $\sim 1.3\%$ . This subset of data alone constrains the amplitude of any long-period variations with period  $P$  to be  $A < 1\%(P/20 \text{ days})^2$ . Over the course of any given  $\sim 5$ -hour segment, the data exhibit significant linear trends not seen in a comparison star of similar magnitude, and in a few cases these segments show clear evidence for curvature at the level of a few millimagnitudes per hour<sup>2</sup>. These properties imply that the rotation period of Sedna is  $O(10 \text{ hours})$ , cannot be  $< 5$  hours, and cannot be  $> 10$  days, unless the intrinsic light curve has significant and comparable power on multiple timescales, which is unlikely. A sinusoidal fit yields a period of  $P = (10.273 \pm 0.002)$  hours and semi-amplitude of  $A = (1.1 \pm 0.1)\%$ . There are additional acceptable fits with flanking periods separated by  $\sim 3$  minutes, as well as another class of fits with  $P \sim 18$  hours, although these later fits appear less viable based on visual inspection. Our results indicate that the period of Sedna is likely consistent with typical rotation periods of solar system objects, thus obviating the need for a massive companion to slow its rotation.

**To appear in: The Astrophysical Journal Letters, 629**

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*or on the web at* <http://arxiv.org/abs/astro-ph/0503673>

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## The Period of Rotation, Shape, Density, and Homogeneous Surface Color of the Centaur 5145 Pholus

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We present optical photometry of the Centaur 5145 Pholus during 2003 May and 2004 April using the facility CCD camera on the 1.8-m Vatican Advanced Technology Telescope on Mt. Graham, Arizona. We derive a double-peaked lightcurve and a rotation period of  $9.980 \pm 0.002$  h for Pholus,

consistent with periods of  $9.9825 \pm 0.004$  and  $9.9823 \pm 0.0012$  h by Buie and Bus (1992, Icarus 100, 288–294) and Farnham (2001, Icarus 152, 238–245). We find a lightcurve peak-to-peak amplitude of 0.60 mag, significantly larger than peak-to-peak amplitude determinations of 0.15 and 0.39 mag by Buie and Bus and Farnham. We use the three observed amplitudes and an amplitude-aspect model to derive four possible rotational pole positions as well as axial ratios of  $a/b = 1.9$  and  $c/b = 0.9$ . If we assume an albedo of 0.04, we find Pholus has dimensions of  $310 \times 160 \times 150$  km. If we assume Pholus is a strengthless rubble-pile and its non-spherical shape is due to rotational distortion, our axial ratios and period measurements indicate Pholus has a density of  $0.5 \text{ g cm}^{-3}$ , suggestive of an ice-rich, porous interior. By combining  $B$ -band and  $R$ -band lightcurves, we find  $B - R = 1.94 \pm 0.01$  and any  $B - R$  color variation over the surface of Pholus must be smaller than 0.06 mag (i.e., much smaller than the  $1.0 < B - R < 2.0$  range seen among the Centaur and Kuiper belt object populations). By combining our  $V - R$  measurements with values in the literature, we find no evidence for any color variegation between the northern and southern hemispheres of Pholus. Observations of the Kuiper belt object 2004 DW (90482) over a time interval of seven hours show no color variation. Our observations add to the growing body of evidence that individual Centaurs and KBOs exhibit homogeneous surface colors and hence gray impact craters on radiation reddened crusts are probably not responsible for the surprising range of colors seen among the Centaur and Kuiper belt object populations.

**Published in: Icarus, 175, 390 (2005 June)**

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## Photometric Study of Centaur (60558) 2000 EC<sub>98</sub> and Trans-Neptunian Object (55637) 2002 UX<sub>25</sub> at Different Phase Angles

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We present photometric observations of Centaur (60558) 2000 EC<sub>98</sub> and trans-neptunian object (55637) 2002 UX<sub>25</sub> at different phase angles and with different filters (mainly  $R$  but also  $V$  and  $B$  for some data). Results for 2000 EC<sub>98</sub> are: (i) a rotation period of  $26.802 \pm 0.042$  hours if a double-peaked lightcurve is assumed, (ii) a lightcurve amplitude of  $0.24 \pm 0.06$  for the  $R$  band, (iii) a phase curve with  $H = 9.03 \pm 0.01$  and  $G = -0.39 \pm 0.08$  ( $R$  filter) and  $H = 9.55 \pm 0.04$  and  $G = -0.50 \pm 0.35$  ( $V$  filter) or a slope of  $0.17 \pm 0.02 \text{ mag deg}^{-1}$  ( $R$  filter) and  $0.22 \pm 0.06$  ( $V$  filter), (iv) the color indices  $B - V = 0.76 \pm 0.15$  and  $V - R = 0.51 \pm 0.09$  (for  $\alpha = 0.1\text{--}0.5$  deg) and  $0.55 \pm 0.08$  (for  $\alpha = 1.4\text{--}1.5$  deg). The rotation period is amongst the longest ever measured for Centaurs and TNOs. We also show that our photometry was not contaminated by any cometary activity down to magnitude  $\simeq 27 \text{ arcsec}^{-2}$ .

For 2002 UX<sub>25</sub> the results are: (i) a rotation period of  $14.382 \pm 0.001$  hours or  $16.782 \pm 0.003$  hours (if a double-peaked lightcurve is assumed) (ii) a lightcurve amplitude of  $0.21 \pm 0.06$  for the  $R$  band (and the 16.782 hours period), (iii) a phase curve with  $H = 3.32 \pm 0.01$  and  $G = +0.16 \pm 0.18$  or a slope of  $0.13 \pm 0.01 \text{ mag deg}^{-1}$  ( $R$  filter), (iv) the color indices  $B - V = 1.12 \pm 0.26$  and  $V - R = 0.61 \pm 0.12$ . The phase curve reveals also a possible very narrow and bright opposition surge. Because such a narrow surge appears only for one point it needs to be confirmed.

**Published in: Icarus 176, 478 [2005 August]**

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## The High-Albedo Kuiper Belt Object (55565) 2002 AW<sub>197</sub>

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We detected thermal emission from the Kuiper Belt object 2002 AW<sub>197</sub> in 2003 December and again in 2004 April using the Multiband Imaging Photometer on the Spitzer Space Telescope. In combination with the absolute visual magnitude, the thermal measurements indicate a geometric albedo of  $0.17 \pm 0.03$  and a diameter of  $700 \pm 50$  km. The albedo of 2002 AW<sub>197</sub> is significantly higher than the 0.04 value typically assumed for trans-Neptunian objects, and consequently the object is smaller than previously thought based on that assumption. Our thermal measurements at two wavelengths (24 and 70  $\mu\text{m}$ ) allow us to constrain the surface temperature and thereby place constraints on the thermal inertia. We find that the standard thermal model (STM) is inconsistent with the 24/70  $\mu\text{m}$  color unless we set the beaming parameter  $\eta > 0.95$ , indicating that the object has a significant thermal inertia and, therefore, that the STM is inappropriate. The other end-member thermal inertia model is the fast-rotator, or isothermal-latitude, model (ILM). The data are well represented by an ILM with the pole of rotation inclined to the Sun by  $45 \pm 10$  deg. The high albedo is consistent with a surface containing significant amounts of weakly absorbing materials, with ices and/or fine-grained silicates as likely candidates.

**Published in: The Astronomical Journal Letters, 624, 53 (2004 May 1)**

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## Higher Albedos and Size Distribution of Large Transneptunian Objects

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Transneptunian objects (TNOs) orbit beyond Neptune and do offer important clues about the formation of our solar system. Although observations have been increasing the number of discovered TNOs and improving their orbital elements, very little is known about elementary physical properties such as sizes, albedos and compositions. Due to TNOs large distances ( $> 40$  AU) and observational limitations, reliable physical information can be obtained only from brighter objects (supposedly larger bodies). According to size and albedo measurements available, it is evident the traditionally assumed albedo  $p = 0.04$  cannot hold for all TNOs, especially those with approximately absolute magnitudes  $H \leq 5.5$ . That is, the largest TNOs possess higher albedos (generally  $> 0.04$ ) that strongly appear to increase as a function of size. Using a compilation of published data, we derived empirical relations which can provide estimations of diameters and albedos as a function of absolute magnitude. Calculations result in more accurate size/albedo estimations for TNOs with  $H \leq 5.5$  than just assuming  $p = 0.04$ . Nevertheless, considering low statistics, the value  $p = 0.04$  sounds still

convenient for  $H > 5.5$  non-binary TNOs as a group. We also discuss about physical processes (e.g., collisions, intrinsic activity and the presence of tenuous atmospheres) responsible for the increase of albedo among large bodies. Currently all big TNOs ( $> 700$  km) would be capable to sustain thin atmospheres or icy frosts composed of  $\text{CH}_4$ ,  $\text{CO}$  or  $\text{N}_2$  even for body bulk densities as low as  $0.5 \text{ g cm}^{-3}$ . A size-dependent albedo has important consequences for the TNOs size distribution, cumulative luminosity function and total mass estimations. According to our analysis, the latter can be reduced up to 50% if higher albedos are common among large bodies. Lastly, by analyzing orbital properties of classical TNOs ( $42 \text{ AU} < a < 48 \text{ AU}$ ), we confirm that cold and hot classical TNOs have different concentration of large bodies. For both populations, distinct absolute magnitude distributions are maximized for an inclination threshold equal 4.5 degrees at  $> 99.63\%$  confidence level. Furthermore, more massive classical bodies are anomalously present at  $a < 43.5 \text{ AU}$ , a result statistically significant and apparently not caused by observational biases. This feature would provide a new constraint for transneptunian belt formation models.

**To appear in: Planetary and Space Science**

*For preprints, contact* patryk@kobe-u.ac.jp

*or on the web at* <http://harbor.scitec.kobe-u.ac.jp/~patryk/index-uk.html>

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## PAPERS RECENTLY SUBMITTED TO JOURNALS

### Keck Observatory Laser Guide Star Adaptive Optics Discovery and Characterization of a Satellite to Large Kuiper Belt Object 2003 EL61

M.E. Brown<sup>1</sup>, A.H. Bouchez<sup>2,3</sup>, D. Rabinowitz<sup>4</sup>, R. Sari<sup>1</sup>, C.A. Trujillo<sup>5</sup>,  
M. van Dam<sup>2</sup>, R. Campbell<sup>2</sup>, J. Chin<sup>2</sup>, S. Hartman<sup>2</sup>, E. Johansson<sup>2</sup>, R. Lafon<sup>2</sup>,  
D. LeMignant<sup>2</sup>, P. Stomski<sup>2</sup>, D. Summers<sup>2</sup>, and P. Wizinowich<sup>2</sup>

<sup>1</sup> Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA

<sup>2</sup> W.M. Keck Observatory, 65-1120 Mamalahoa Highway, Kamuela, HI 96743, USA

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Submitted to: The Astrophysical Journal Letters

*preprints on the web at* [www.gps.caltech.edu/~mbrown/papers](http://www.gps.caltech.edu/~mbrown/papers)

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## OTHER PAPERS OF INTEREST

### **Kuiper Binary Object Formation**

**R.C. Nazzario<sup>1</sup>, K.Orr<sup>1</sup>, C.Covington<sup>1</sup>, D.Kagan<sup>1</sup>, and T.W. Hyde<sup>1</sup>**

<sup>1</sup> Center for Astrophysics, Space Physics and Engineering Research, Baylor University, Waco, TX 76798-7310, USA

*Preprints on the web at* <http://arxiv.org/abs/astro-ph/0507149>

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### **Signatures of Planets in Spatially Unresolved Debris Disks**

**A. Moro-Martín<sup>1</sup>, S. Wolf<sup>2</sup>, and R. Malhotra<sup>3</sup>**

<sup>1</sup> Department of Astrophysical Sciences, Princeton University, Princeton NJ 08544, USA

<sup>2</sup> Max-Planck-Institut für Astronomie, Königstuhl 17, 69117 Heidelberg, Germany

<sup>3</sup> Department of Planetary Sciences, University of Arizona, 1629 E. University Boulevard, Tucson, AZ 85721, USA

Published in: *The Astrophysical Journal*, 621, 1079 (2005 March 10)

*For preprints, contact* [amaya@astro.princeton.edu](mailto:amaya@astro.princeton.edu)

*or on the web at* <http://www.astro.princeton.edu/~amaya/publications/publications.html>

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### **Dust Outflows and Inner Gaps Generated by Massive Planets in Debris Disks**

**A. Moro-Martín<sup>1</sup> and R. Malhotra<sup>2</sup>**

<sup>1</sup> Department of Astrophysical Sciences, Princeton University, Princeton NJ 08544, USA

<sup>2</sup> Department of Planetary Sciences, University of Arizona, 1629 E. University Boulevard, Tucson, AZ 85721, USA

To appear in: *The Astrophysical Journal*

*For preprints, contact* [amaya@astro.princeton.edu](mailto:amaya@astro.princeton.edu)

*or on the web at* <http://www.astro.princeton.edu/~amaya/publications/publications.html>

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### **Spitzer Observations of G Dwarfs in the Pleiades: Circumstellar Debris Disks at 100 Myr Age**

**John R. Stauffer<sup>1</sup>, Luisa M. Rebull<sup>1</sup>, John M. Carpenter<sup>2</sup>, Lynne A. Hillenbrand<sup>2</sup>, Dana Backman<sup>3</sup>, Michael Meyer<sup>4</sup>, Jinyoung Serena Kim<sup>4</sup>, Murray Silverstone<sup>4</sup>, Erick Young<sup>4</sup>, Dean C. Hines<sup>5</sup>, David R. Soderblom<sup>6</sup>, Eric Mamajek<sup>7</sup>, Patrick Morris<sup>8</sup>, Jeroen Bouwman<sup>9</sup>, and Stephen E. Strom<sup>10</sup>**

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To appear in: *The Astronomical Journal*

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*or on the web at* <http://arxiv.org/abs/astro-ph/0506743>

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# Formation and Evolution of Planetary Systems: Cold Outer Disks Associated with Sun-like stars

Jinyoung Serena Kim<sup>1</sup>, Dean C. Hines<sup>2</sup>, Dana E. Backman<sup>3</sup>, Lynne A. Hillenbrand<sup>4</sup>,  
Michael R. Meyer<sup>1</sup>, Jens Rodmann<sup>5</sup>, Amaya Moro-Martín<sup>6</sup>, John M. Carpenter<sup>4</sup>, Mur-  
ray D. Silverstone<sup>1</sup>, Jeroen Bouwman<sup>5</sup>, Eric E. Mamajek<sup>7</sup>, Sebastian Wolf<sup>4</sup>, Renu Malhotra<sup>8</sup>,  
Ilaria Pascucci<sup>1</sup>, Joan Najita<sup>9</sup>, Deborah L. Padgett<sup>10</sup>, Thomas Henning<sup>5</sup>, Timothy Y. Brooke<sup>4</sup>,  
Martin Cohen<sup>11</sup>, Stephen E. Strom<sup>9</sup>, Elizabeth B. Stobie<sup>1</sup>, Charles W. Engelbracht<sup>1</sup>,  
Karl D. Gordon<sup>1</sup>, Karl Misselt<sup>1</sup>, Jane E. Morrison<sup>1</sup>, James Muzerolle<sup>1</sup>, and Kate Y. L. Su<sup>1</sup>

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Blvd., Tucson, AZ 85721-0092, USA

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To appear in: The Astrophysical Journal

*For preprints, contact* `serena@as.arizona.edu`

*or on the web at* [http://globule.as.arizona.edu/~serena/publications/JSK\\_cold\\_disks.ps](http://globule.as.arizona.edu/~serena/publications/JSK_cold_disks.ps)

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## Cold Compaction of Water Ice

W.B. Durham<sup>1</sup>, W.B. McKinnon<sup>2</sup>, and L.A. Stern<sup>3</sup>

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Geophysical Research Letters

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# CONFERENCE CONTRIBUTIONS

The 37th DPS meeting will be held on 2005 September 4–9 at the University of Cambridge, UK. The program is listed at:

<http://www.aas.org/publications/baas/v37n3/dps2005/dps2005block.html>

Below is a listing of the Kuiper belt related presentations I have culled from the schedule (apologies for any I missed):

- **Session 3. Asteroids I**

Oral, Monday, September 5, 2005, 11:00am-12:30pm, Law LG19

<http://www.aas.org/publications/baas/v37n3/dps2005/S30.htm>

- 3.01 *The Pan-STARRS Large Survey Telescope Project*

N. Kaiser (IfA, U. Hawaii), Pan-STARRS Project Team

<http://www.aas.org/publications/baas/v37n3/dps2005/801.htm>

- 3.02 *Orbit determination for the next generation asteroid/comet surveys*

A. Milani (University of Pisa, Italy)

<http://www.aas.org/publications/baas/v37n3/dps2005/490.htm>

- **Session 29. Planet and Satellite Formation**

Poster, Tuesday, September 6, 2005, 6:00-7:15pm, Music Foyer

<http://www.aas.org/publications/baas/v37n3/dps2005/S290.htm>

- 29.10 *The Evidence of an Early Stellar Encounter in Edgeworth-Kuiper Belt*

H. Kobayashi (Nagoya University), S. Ida (Tokyo Tech), H. Tanaka (Hokkaido University)

<http://www.aas.org/publications/baas/v37n3/dps2005/303.htm>

- 29.14 *Collisional Evolution of the Primordial Trans-Neptunian Disk: Implications for Planetary Migration and the Current Size Distribution of TNOs*

D. P. O'Brien, A. Morbidelli (Observatoire de la Cote d'Azur), W. F. Bottke (Southwest Research Institute)

<http://www.aas.org/publications/baas/v37n3/dps2005/520.htm>

- **Session 36. Icy Satellites I**

Oral, Wednesday, September 7, 2005, 11:45am-12:45pm, Law LG19

<http://www.aas.org/publications/baas/v37n3/dps2005/S360.htm>

- 36.06 *Albedo of Irregular Satellites of the Giant Planets*

T. Grav (University of Hawaii)

<http://www.aas.org/publications/baas/v37n3/dps2005/360.htm>

- **Session 49. Pluto and Charon**

Oral, Thursday, September 8, 2005, 9:00–10:00am, Law LG19

<http://www.aas.org/publications/baas/v37n3/dps2005/S490.htm>

- 49.01 *Pluto: the next decade of discovery*

L.A. Young (SwRI)

<http://www.aas.org/publications/baas/v37n3/dps2005/780.htm>

- 49.02 *Ice XI on Pluto and Charon?*  
W. B. McKinnon, A. M. Hofmeister (Washington Univ, Saint Louis)  
<http://www.aas.org/publications/baas/v37n3/dps2005/805.htm>
- 49.03 *Mapping the Surface of Pluto with the Hubble Space Telescope*  
M.W. Buie, W.M. Grundy (Lowell Obs.), E.F. Young, L.A. Young, S.A. Stern (SwRI, Boulder)  
<http://www.aas.org/publications/baas/v37n3/dps2005/613.htm>
- 49.04 *Resolved, Time-Series Observations of Pluto-Charon with the Magellan Telescopes*  
J. L. Elliot, M. J. Person, E. R. Adams, A. A. S. Gulbis, E. A. Kramer (Department of Earth, Atmospheric, and Planetary Sciences, MIT)  
<http://www.aas.org/publications/baas/v37n3/dps2005/449.htm>
- 49.05 *The 11 July 2005 Charon stellar occultation*  
B. Sicardy, F. Colas, T. Widemann, A. Bellucci, E. Frappa, E. Gendron, S. Lacour, J. Lecacheux, S. Pau, J. Quintanilla, S. Renner, F. Roques, F. Vachier (Obs. Paris, France), N. Ageorges, O. Hainaut (ESO/Paranal, Chile), W. Beisker (IOTA - ES), A. Maury (Space Obs, S. Pedro, Chile), D. Lazzaro, R. Martins, C. Veiga (Obs. Nacional, Brazil), O. Mousis, P. Rousselot (Obs. Besancon, France), J.-F. Lecampion (Obs. Bordeaux, France), H. Levato (Obs. El Leoncito, Argentina), R. Zalles (Obs. Tarija, Bolivia)  
<http://www.aas.org/publications/baas/v37n3/dps2005/264.htm>

- **Session 52. TNOs and Centaurs**

Oral, Thursday, September 8, 2005, 2:00–3:50pm, Law LG19

<http://www.aas.org/publications/baas/v37n3/dps2005/S520.htm>

- 52.01 *Sources of Centaurs and Jupiter-family Comets*  
M.E. Bailey (Armagh Observatory, Northern Ireland), V.V. Emel'yanenko (South Ural University, Russia), D.J. Asher (Armagh Observatory, Northern Ireland)  
<http://www.aas.org/publications/baas/v37n3/dps2005/339.htm>
- 52.02 *TNOs' taxonomy*  
M. Fulchignoni, M.A. Barucci (LESIA, Observatoire de Paris, France), I.N. Belskaya (Institute of Astronomy Kharkiv, Ukraine), M. Birlain (IMCCE, Observatoire de Paris, France)  
<http://www.aas.org/publications/baas/v37n3/dps2005/290.htm>
- 52.03 *Dynamical and Physical Models of Ecliptic Comets*  
L. Dones, D. C. Boyce, H. F. Levison (SwRI), M. J. Duncan (Queen's University)  
<http://www.aas.org/publications/baas/v37n3/dps2005/453.htm>
- 52.04 *Kuiper Belt Binaries: Masses, Colors, and a Density*  
J. L. Margot (Cornell University), M. E. Brown (Caltech), C. A. Trujillo (Gemini), R. Sari (Caltech), J. A. Stansberry (U of Arizona)  
<http://www.aas.org/publications/baas/v37n3/dps2005/781.htm>
- 52.05 *Albedos, Diameters (and a Density) of Kuiper Belt and Centaur Objects*  
J.A. Stansberry, D.P. Cruikshank (NASA Ames), W.G. Grundy (Lowell Observatory), J.L. Margot (Cornell), J.P. Emery (SETI Inst.), Y.R. Fernandez (U. Hawaii), G.H. Rieke (U. Arizona)  
<http://www.aas.org/publications/baas/v37n3/dps2005/446.htm>

- 52.06 *Near Infrared Spectra from Mauna Kea of the New Brightest Kuiper Belt Object*  
C. A. Trujillo (Gemini Observatory), K. M. Barkume, M. Brown, E. L. Schaller (Caltech),  
D. L. Rabinowitz (Yale)  
<http://www.aas.org/publications/baas/v37n3/dps2005/451.htm>
- 52.07 *Spitzer/MIPS Survey of Classical Kuiper Belt Objects and a Neptune Trojan*  
W.M. Grundy (Lowell Obs.), J.R. Spencer (SwRI), J.A. Stansberry (U. Arizona), M.W.  
Buie (Lowell Obs.), E.I. Chiang (U.C. Berkeley), D.P. Cruikshank (NASA Ames), R.L.  
Millis, L.H. Wasserman (Lowell Obs.)  
<http://www.aas.org/publications/baas/v37n3/dps2005/703.htm>
- 52.08 *The Relationship Between KBO Colors and Kuiper-belt Plane Inclination*  
J.F. Kane, A.A.S. Gulbis, J.L. Elliot (MIT)  
<http://www.aas.org/publications/baas/v37n3/dps2005/585.htm>
- 52.09 *New VLT BVRI Photometry on Trans-Neptunian Objects and Centaurs.*  
P. Santos-Sanz, J.L. Ortiz (Instituto de Astrofísica de Andalucía-CSIC.), H. Boehnhardt  
(Max-Planck-Institute für Solar System Research.), L. Barrera (Universidad Metropolita-  
nana de Ciencias de la Educación.)  
<http://www.aas.org/publications/baas/v37n3/dps2005/496.htm>
- 52.10 *Studies of Kuiper Belt Binaries*  
S. D. Kern, J. L. Elliot (MIT)  
<http://www.aas.org/publications/baas/v37n3/dps2005/83.htm>
- 52.11 *Near Infrared Spectroscopy of Icy Planetoids*  
K. M. Barkume, M. E. Brown, E. L. Schaller (Caltech)  
<http://www.aas.org/publications/baas/v37n3/dps2005/272.htm>

• **Session 55. Pluto and Charon**

Poster, Thursday, September 8, 2005, 6:00-7:15pm, Music Recital Room

<http://www.aas.org/publications/baas/v37n3/dps2005/S550.htm>

- 55.01 *Sub-Arcsecond Scale Imaging of the Pluto/Charon Binary System at 1.4 mm*  
M.A. Gurwell (CfA), B.J. Butler (NRAO)  
<http://www.aas.org/publications/baas/v37n3/dps2005/668.htm>
- 55.02 *Evidence of Tholins on Pluto's Surface from Near-IR and IR Spectroscopy*  
C. B. Olkin, E. F. Young, L. A. Young (SwRI), W. Grudy (Lowell Obs.), B. Schmitt  
(Lab. de Plantologie de Grenoble, France)  
<http://www.aas.org/publications/baas/v37n3/dps2005/761.htm>
- 55.03 *Results from PIXON-Processed HRC Images of Pluto*  
E.F. Young (Southwest Research Institute), M.W. Buie (Lowell Observatory), L.A. Young  
(Southwest Research Institute)  
<http://www.aas.org/publications/baas/v37n3/dps2005/773.htm>
- 55.04 *New Occultation Systems and the 2005 July 11 Charon Occultation*  
L.A. Young (SwRI), R.G. French (Wellesley College), B. Gregory (CTIO), C.B. Olkin  
(SwRI), C. Ruhland (U. Chicago), K. Shoemaker (Shoemaker Labs), E.F. Young (SwRI)  
<http://www.aas.org/publications/baas/v37n3/dps2005/635.htm>

• **Session 56. TNOs and Centaurs**

Poster, Thursday, September 8, 2005, 6:00-7:15pm, Music Recital Room

<http://www.aas.org/publications/baas/v37n3/dps2005/S560.htm>

- 56.01 *Nitrogen and Methane Ices on the Surface of Sedna?*  
M.A. Barucci (LESIA, Paris Observatory), D.P. Cruikshank (NASA Ames Research Center), E. Dotto (INAF-OAR), F. Merlin (LESIA, Paris Observatory), F. Poulet (IAS-Orsay), C. Dalle Ore (NASA Ames Research Center), S. Fornasier (Dipart. di Astronomia, Padova), C. de Bergh (LESIA, Paris Observatory)  
<http://www.aas.org/publications/baas/v37n3/dps2005/287.htm>
- 56.02 *Keck Laser Guide Star Adaptive Optics Discovery and Characterization of a Large Kuiper Belt Object Satellite*  
A. Bouchez, M. Brown (Caltech), R. Campbell, J. Chin, M. van Dam, S. Hartman, E. Johansson, R. Lafon, D. Le Mignant, P. Stomski, D. Summers, P. Wizinowich (Keck Observatory), C. Trujillo (Gemini Observatory), D. Rabinowitz (Yale University)  
<http://www.aas.org/publications/baas/v37n3/dps2005/786.htm>
- 56.03 *Modelling the Populations of Trans-Neptunian Objects.*  
A. Campo Bagatin, P.G. Benavidez (Universidad de Alicante. Alicante (Spain))  
<http://www.aas.org/publications/baas/v37n3/dps2005/114.htm>
- 56.04 *Thermal Structure of Centaur Objects*  
Y. J. Choi (Jet Propulsion Laboratory), D. Prrialnik, N. Brosch (Tel Aviv University)  
<http://www.aas.org/publications/baas/v37n3/dps2005/767.htm>
- 56.05 *Centaur Colors: New Data and Analysis*  
G. J. Consolmagno (Specola Vaticana), W. Romanishin (University of Oklahoma), S. C. Tegler (Northern Arizona University)  
<http://www.aas.org/publications/baas/v37n3/dps2005/346.htm>
- 56.06 *Spectrum Models of High-Albedo Kuiper Belt Objects and Centaurs*  
C. M. Dalle Ore (SETI/NASA Ames), D. P. Cruikshank (NASA Ames)  
<http://www.aas.org/publications/baas/v37n3/dps2005/345.htm>
- 56.07 *Evolution of the Oort Cloud under Galactic Perturbations*  
A. Higuchi (NAOJ/Kobe University), E. Kokubo (NAOJ), T. Mukai (Kobe University)  
<http://www.aas.org/publications/baas/v37n3/dps2005/282.htm>
- 56.08 *Capture of Centaurs into Trojan-like Orbits*  
J. Horner (University of Bern), N. W. Evans (University of Cambridge)  
<http://www.aas.org/publications/baas/v37n3/dps2005/314.htm>
- 56.09 *Alteration of cometary composition through collisions: preliminary results*  
Z.M. Leinhardt, S.T. Stewart-Mukhopadhyay (Dept of Earth and Planetary Sciences, Harvard University)  
<http://www.aas.org/publications/baas/v37n3/dps2005/701.htm>
- 56.10 *Proton Irradiation of Crystalline Water Ice: Timescales for Amorphization in the Kuiper Belt*  
R. M. E. Mastrapa (NASA Ames Research Center), M. H. Moore (NASA Goddard Space Flight Center), R. L. Hudson (Eckerd College), R. L. Ferrante (U. S. Naval Academy), R. H. Brown (University of Arizona)  
<http://www.aas.org/publications/baas/v37n3/dps2005/604.htm>



- 56.11 *Infrared Photometry of Kuiper Belt Objects with NICMOS*  
K. Noll (STScI), D. Stephens (JHU), W. Grundy (Lowell Obs.), D. Cruikshank (NASA Ames), W. Romanishin (U. Oklahoma), S. Tegler (NAU)  
<http://www.aas.org/publications/baas/v37n3/dps2005/700.htm>
  - 56.12 *Photometric observations of a very bright TNO with an extraordinary lightcurve.*  
D. Rabinowitz, S. Tourtellotte (Yale University), M. Brown (Caltech), C. Trujillo (Gemini Observatory)  
<http://www.aas.org/publications/baas/v37n3/dps2005/320.htm>
  - 56.13 *The Kuiper Belt explored by Stellar Occultations*  
F. Roques, A. Doressoundiram (Observatoire de Paris, France)  
<http://www.aas.org/publications/baas/v37n3/dps2005/814.htm>
  - 56.14 *Nightly Observations in BVI of 25 KBOs and Centaurs Over a Whole Observing Season*  
B. E. Schaefer (Louisiana S. U.), D. Rabinowitz, S. Tourtellotte (Yale)  
<http://www.aas.org/publications/baas/v37n3/dps2005/391.htm>
  - 56.15 *A Deep Survey for Trojan Asteroids of Saturn, Uranus and Neptune*  
S. S. Sheppard (Carnegie Institution of Washington), C. Trujillo (Gemini Observatory)  
<http://www.aas.org/publications/baas/v37n3/dps2005/765.htm>
  - 56.16 *The High Fraction of Binaries in the Cold Classical Kuiper Belt*  
D.C. Stephens (JHU), K.S. Noll (STScI)  
<http://www.aas.org/publications/baas/v37n3/dps2005/636.htm>
  - 56.17 *Status of the Deep Ecliptic Survey*  
L.H. Wasserman, M.W. Buie, R.L. Millis (Lowell Observatory), J.L. Elliot, S.D. Kern, A.A.S. Gulbis, K.B. Clancy (MIT), D.E. Trilling (U. AZ), E.I. Chiang (U.C. Berkeley), K.M. Meech (U. Hawaii)  
<http://www.aas.org/publications/baas/v37n3/dps2005/776.htm>
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# BOOKS

Call for chapter volunteers for a new book in the Space Science Series, on the topic of...

## THE KUIPER BELT

Edited by

**A. Barucci, H. Boehnhardt, D. Cruikshank, A. Morbidelli**  
(publication at end 2007)

Over the last 13 years, the outer solar system has been found to be densely populated by many bodies called Kuiper Belt or Trans-Neptunian Objects. These discoveries have opened up a new frontier in solar system astronomy. The scientific community has developed scenarios for the understanding of the Kuiper Belt. This field of research continues to evolve rapidly with the promise of an exciting future.

For these reasons, the time has come to begin work on a Kuiper Belt book to be published in the Space Science Series of the University of Arizona Press. A Scientific Organizing Committee (SOC) has been formed and has made preliminary plans for the organization and content of this book.

See: <http://www.lesia.obspm.fr/planeto/KuiperBook/> for more information, preliminary outline, and further information on how to respond to this "Call for Papers".

The deadline for response is 1 October 2005.

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The *Distant EKO*s 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 L<sup>A</sup>T<sub>E</sub>X 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 EKO*s 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.

*Distant EKO*s 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 EKO*s is not a substitute for peer-reviewed journals.

### **Moving ... ??**

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