Issue No. 53 *July 2007*

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 28 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2006 QD181, 2006 QE181, 2006 QF181, 2006 QL181, 2006 QN181, 2006 QP181, 2006 QQ181, 2006 QR180, 2006 QS180, 2006 QT180, 2006 QU180, 2006 QV180, 2006 QW180, 2006 QX180, 2006 QZ180, 2006 UK321, 2006 UM321, 2006 UN321, 2006 UO321, 2006 UP321, 2006 UQ321, 2006 UR321, 2006 US321, 2006 UT321, 2007 JF43, 2007 JH43, 2007 JJ43, 2007 HV90

and 3 new Centaur/SDO discoveries:

2006 UL321, 2007 JG43, 2007 JK43

Current number of TNOs: 1054 (including Pluto)
Current number of Centaurs/SDOs: 199
Current number of Neptune Trojans: 5

Out of a total of 1258 objects:
539 have measurements from only one opposition
473 of those have had no measurements for more than a year
252 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

The Mass of Dwarf Planet Eris

M.E. Brown[1] and E.L. Schaller[1]

[1] Division of Geological and Planetary Sciences, Caltech, Pasadena, CA 91125, USA

The discovery of dwarf planet Eris was followed shortly by the discovery of its satellite, Dysnomia, but the satellite orbit, and thus the system mass, was not known. New observations with the Keck Observatory and the Hubble Space Telescopes show that Dysnomia has a circular orbit with a radius of 37,350 ± 140 (1-σ) kilometers and a 15.774 ± 0.002 day orbital period around Eris. These orbital parameters agree with expectations for a satellite formed out of the orbiting debris left from a giant impact. The mass of Eris from these orbital parameters is $1.67 \times 1022 \pm 0.02 \times 10^{22}$ kilograms, or 1.27 ± 0.02 that of Pluto.

Published in: Science, 316, 1585 (2007 June 15)
Preprints available on the web at `http://www.gps.caltech.edu/~mbrown/papers`

. . . . . .

Resonance Sticking in the Scattered Disk

Patryk Sofia Lykawka[1] and Tadashi Mukai[1]

[1] Kobe University, Department of Earth and Planetary Sciences, 1-1 rokkodai, nada-ku, Kobe, 657-8501, Japan

We investigate the dynamical evolution of trans-Neptunian objects (TNOs) in typical scattered disk orbits (scattered TNOs) by performing simulations using several thousand particles lying initially on Neptune-encountering orbits. We explore the role of resonance sticking in the scattered disk, a phenomenon characterized by multiple temporary resonance captures ('resonances' refers to external mean motion resonances with Neptune, which can be described in the form r:s, where the arguments r and s are integers). First, all scattered TNOs evolve through intermittent temporary resonance capture events and gravitational scattering by Neptune. Each scattered TNO experiences tens to hundreds of resonance captures over a period of 4 Gyr, which represents about 38% of the object's lifetime (mean value). Second, resonance sticking plays an important role at semimajor axes $a < 250$ AU, where the great majority of such captures occurred. It is noteworthy that the stickiest (i.e., dominant) resonances in the scattered disk are located within this distance range and are those possessing the lowest argument s. This was evinced by r:1, r:2 and r:3 resonances, which played the greatest role during resonance sticking evolution, often leading to captures in several of their neighboring resonances. Finally, the timescales and likelihood of temporary resonance captures are roughly proportional to resonance strength. The dominance of low s resonances is also related to the latter. In sum, resonance sticking has an important impact on the evolution of scattered TNOs, contributing significantly to the longevity of these objects.

To appear in: Icarus
For preprints, contact `patryk@dragon.kobe-u.ac.jp`
or on the web at `http://harbor.scitec.kobe-u.ac.jp/~patryk/index-en.html`

. . . . . .

The Dynamical Stability of a Kuiper Belt-like Region

A. Celletti[1], T. Kotoulas[2], G.Voyatzis[2], and J. Hadjidemetriou[2]

[1] Department of Mathematics, University of Roma Tor Vergata, Via della Ricerca Scientifica 1, I-00133 Roma, Italy

[2] Department of Physics, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

The dynamics of the Kuiper Belt region between 33 and 63 AU is investigated just taking into account the gravitational influence of Neptune. Indeed the aim is to analyse the information which can be drawn from the actual exoplanetary systems, where typically physical and orbital data of just one or two planets are available. Under this perspective we start our investigation using the simplest three-body model (with Sun and Neptune as primaries), adding at a later stage the eccentricity of Neptune and the inclinations of the orbital planes to evaluate their effects on the Kuiper Belt dynamics. Afterwards we remove the assumption that the orbit of Neptune is Keplerian by adding the effect of Uranus through the Lagrange-Laplace solution or through a suitable resonant normal form. Finally, different values of the mass ratios of the primary to the host star are considered in order to perform a preliminary analysis of the behaviour of exoplanetary systems. In all cases, the stability is investigated by means of classical tools borrowed from dynamical system theory, like Poincaré mappings and Lyapunov exponents.

Published in: Monthly Notices of the Royal Astronomical Society, 378, 1153 (2007 July)

For preprints, contact `celletti@mat.uniroma2.it`

. . . . . .

Possible Patterns in the Distribution of Planetary Formation Regions

J.L. Ortiz[1], F. Moreno[1], A. Molina[1], P. Santos Sanz[1], and P.J. Gutiérrez[1]

[1] Instituto de Astrofísica de Andalucía-CSIC, Spain

Eris, an object larger than Pluto, is known to reside in the transneptunian region further away than Pluto. One can wonder whether its semimajor orbital axis fits in a generalized Titius-Bode law, in the same way as Pluto does. We performed a new least squares fit to a generalized Titius-Bode law including Eris and found that not only does Eris fit in the trend, but also that the correlation coefficient improves. In addition, there is a remarkable symmetry of the location of the planetary formation regions with respect to Jupiter when the natural logarithm of the heliocentric distance is used as the metric. The issue of whether the observed patterns have some physical meaning or are due to mere chance is addressed using a Monte Carlo approach identical to that by Lynch (Lynch, P. On the significance of Titius-Bode law for the distribution of planets. Mon. Not. R. Astron. Soc. 341, 1174-1178. 2003). Although the probability of chance occurrence is highly dependent on the way in which the random configurations of synthetic planetary systems are selected, we find that in all reasonable scenarios of random planetary systems the probability of chance occurrence of the observed patterns is small (below 1% in most cases). If the trend were used as a prediction tool, one might expect another planet or dwarf planet or a swarm of bodies with semimajor orbital axis of 120 AU $\pm$ 20 AU. Simple calculations show that the protoplanetary nebula most likely had enough mass to allow the accretion of at least a dwarf planet at that distance. We also found that if the surface density of the nebula decayed with heliocentric distance (r) as a power of -2, the regular spacing in ln(r) in the solar system could be a natural consequence of the existence of a threshold mass for planetary formation.

To appear in: Monthly Notices of the Royal Astronomical Society

For preprints, contact `ortiz@iaa.es`

or on the web at `www.iaa.es/~ortiz/papers/ortizetalpreprint.pdf`

. . . . . .

Dynamical Behaviour of Planetesimals Temporarily Captured by a Planet from Heliocentric orbits: Basic Formulation and the Case of Low Random Velocity

Kazunori Iwasaki[1] **and Keiji Ohtsuki**[1]

[1] Laboratory for Atmospheric and Space Physics, University of Colorado, 392 UCB, Boulder, CO 80309-0392, USA

Planetesimals encountering with a planet cannot be captured permanently unless energy dissipation is taken into account, but some of them can be temporarily captured in the vicinity of the planet for an extended period of time. Such a process would be important for the origin and dynamical evolution of irregular satellites, short-period comets, and Kuiper-belt binaries. In this paper, we describe the basic formulation for the study of temporary capture of planetesimals from heliocentric orbits using three-body orbital integration, such as the definition of the duration and rate of temporary capture, and present results in the case of low random velocity of planetesimals. In the case of planetesimals initially on circular orbits, we find that planetesimals undergo a close encounter with the planet before they become temporarily captured. When planetesimals are scattered by the planet into the vicinity of one of periodic orbits around the planet, the duration of temporary capture tends to be extended. Typically, these capture orbits are in the retrograde direction around the planet. We evaluate the rate of temporary capture of planetesimals, and find that the ratio of this rate to their collision rate on to the planet increases with increasing semimajor axis of the planet. Similar results are obtained for planetesimals with non-zero but small random velocities, as long as Kepler shear dominates the relative velocity between the planet and planetesimals. For larger initial random velocities of planetesimals, temporary capture in both prograde and retrograde directions with much longer duration becomes possible.

Published in: Monthly Notices of the Royal Astronomical Society, 377, 1763 (2007 June)

For preprints, contact `iwasaki@lasp.colorado.edu`

. . . . . .

Production of Trans-Neptunian Binaries through Chaos-assisted Capture

E.A. Lee[1]**, S.A. Astakhov**[2,3] **and D. Farrelly**[2]

[1] FivePrime Therapeutics, 1650 Owens Street, Suite 200, San Francisco, CA 94158-2216, USA

[2] Department of Chemistry and Biochemistry, Utah State University, Logan, UT 84322-0300, USA

[3] UniqueICs, Stroiteley 1, Saratov 410044, Russia

The recent discovery of binary objects in the Kuiper Belt opens an invaluable window into past and present conditions in the trans-Neptunian part of the Solar System. For example, knowledge of how these objects formed can be used to impose constraints on planetary formation theories. We have recently proposed a binary object formation model based on the notion of chaos-assisted capture (CAC). In this model two potential binary partners may become trapped for long times inside chaotic layers within their mutual Hill sphere. The binary may then be captured permanently through gravitational scattering with a third intruder body. The creation of binaries having similarly sized partners is an *ab initio* prediction of the model which also predicts large binary semimajor axes and moderately eccentric mutual orbits similar to those observed. Here we present a more detailed analysis with calculations performed in the spatial (three-dimensional) three- and four-body Hill approximations. It is assumed that the potential binary partners are initially following heliocentric Keplerian orbits and that their relative motion becomes perturbed as these objects undergo close encounters. First, the mass, velocity and orbital element distributions which favour binary formation are identified in the circular and elliptical

Hill limits. We then consider intruder scattering to the circular Hill four-body problem and find that the CAC mechanism is consistent with observed, apparently randomly distributed, binary mutual orbit inclinations. It also predicts asymmetric distributions of retrograde versus prograde orbits. The time-delay induced by chaos on particle transport through the Hill sphere is analogous to the formation of a resonance in a chemical reaction. Implications for binary formation rates are considered and the fine-tuning problem recently identified by Noll et al. is also addressed.

To appear in: Monthly Notices of the Royal Astronomical Society
For preprints, contact ernestine.lee@gmail.com
or on the web at http://arxiv.org/abs/0705.0475

. . . . . .

Near-Infrared Spectroscopy of Charon: Possible Evidence for Cryovolcanism on Kuiper Belt Objects

J. Cook[1,2], S. Desch[2], T. Roush[3], C. Trujillo[4] and T. Geballe[4]

[1] Southwest Research Institute, 1050 Walnut Street, Suite 300, Boulder, CO, 80302, USA

[2] Arizona State University, School of Earth and Space Exploration, Tempe, AZ 85287, USA

[3] NASA Ames Research Center, Mail Stop 245-3, Moffett Field, CA 94035, USA

[4] Gemini Observatory, 670 North A'ohoku Place, Hilo, HI 96720, USA

We present the first reported adaptive optics spectra of Charon in the H and K bands, which examine the anti-Pluto and sub-Pluto hemispheres. The ice temperature is estimated at 40–50 K, based on the 1.65 μm feature of crystalline water ice. We obtain the most accurate profiles of the 2.21 μm feature and confirm that the feature is due to hydrated ammonia. We attribute hemispheric differences in the feature's profile to different hydration states. We calculate the rate at which crystalline water ice is amorphized by solar UV/visible radiation, finding that at the depths probed by H and K observations ($\sim$350 μm), the e-folding time to amorphize ice is (3-5)$\times 10^4$ yr. This implies Charon's ice crystallized from a melt, or has been heated to $\gtrsim$90 K, during the last $\sim 10^5$ yr. The extent of the crystalline water ice and the short timescales involved argue that surface renewal is necessary, a conclusion reinforced by the presence of ammonia hydrates. We investigate possible mechanisms for surface renewal and conclude that cryovolcanism is the most likely.

Published in: The Astrophysical Journal, 663, 1406 (2007 July 10)
For preprints, contact jccook@boulder.swri.edu

. . . . . .

Interpretation of the Near-IR Spectra of the Kuiper Belt Object (136472) 2005 FY_9

Janusz Eluszkiewicz[1], Karen Cady-Pereira[1], Michael E. Brown[2], and John A. Stansberry[3]

[1] Atmospheric and Environmental Research, Inc., Lexington, Massachusetts, USA

[2] Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California, USA

[3] Steward Observatory, University of Arizona, Tucson, Arizona, USA

Visible and near-IR observations of the Kuiper Belt Object (136472) 2005 FY_9 have indicated the presence of unusually long (1 cm or more) optical path lengths in a layer of methane ice. Using microphysical and radiative transfer modeling, we show that even at the frigid temperatures in the outer

reaches of the solar system, a slab of low-porosity methane ice can indeed form by pressureless sintering of micron-sized grains, and it can qualitatively reproduce the salient features of the measured spectra. A good semiquantitative match with the near-IR spectra can be obtained with a realistic slab model, provided the spectra are scaled to a visible albedo of 0.6, at the low end of the values currently estimated from *Spitzer* thermal measurements. Consistent with previous modeling studies, matching spectra scaled to higher albedos requires the incorporation of strong backscattering effects. The albedo may become better constrained through an iterative application of the slab model to the analysis of the thermal measurements from Spitzer and the visible/near-IR reflectance spectra. The slab interpretation offers two falsifiable predictions: (1) Absence of an opposition surge, which is commonly attributed to the fluffiness of the optical surface. This prediction is best testable with a spacecraft, as Earth-based observations at true opposition will not be possible until early next century. (2) Unlikelihood of the simultaneous occurrence of very long spectroscopic path lengths in both methane and nitrogen ice on the surface of any Kuiper Belt Object, as the more volatile nitrogen would hinder densification in methane ice.

Published in: Journal of Geophysical Research, 112, E06003 (2007 June)

. . . . . .

Changes in Pluto's Atmosphere: 1988–2006

J.L. Elliot[1,2,3], M.J. Person[1], A.A.S. Gulbis[1], S.P. Souza[4], E.R. Adams[1], B.A. Babcock[5], J.W. Gangestad[4,6], A.E. Jaskot[4], E.A. Kramer[1], J.M. Pasachoff[4], R.E. Pike[1], C.A. Zuluaga[1], A.S. Bosh[7], S.W. Dieters[8], P.J. Francis[9], A.B. Giles[8], J.G. Greenhill[8], B. Lade[10], R. Lucas[11], and D.J. Ramm[12]

[1] Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139-4307, USA

[2] Department of Physics, Massachusetts Institute of Technology, Cambridge, MA 02139-4307, USA

[3] Lowell Observatory, Flagstaff, AZ 86001, USA

[4] Astronomy Department, Williams College, Williamstown, MA 01267-2565, USA

[5] Physics Department, Williams College, Williamstown, MA 01267-2565, USA

[6] Current address: Department of Aeronautics and Astronautics, Purdue University, West Lafayette, IN 47907, USA

[7] Department of Astronomy, Boston University, Boston, MA 02215, USA; current address: Lowell Observatory, Flagstaff, AZ 86001, USA

[8] School of Mathematics and Physics, University of Tasmania, Hobart, TAS 7001, Australia

[9] Research School of Astronomy and Astrophysics, Australian National University, Mount Stromlo Observatory, Weston, ACT 2611, Australia

[10] Astronomical Society of South Australia, Inc., Adelaide, SA 5001, Australia

[11] School of Physics, University of Sydney, NSW 2006, Australia

[12] Department of Physics and Astronomy, University of Canterbury, Christchurch, New Zealand

The 2006 June 12 occultation of the star P384.2 (2UCAC 26039859) by Pluto was observed from five sites in south-eastern Australia with high-speed imaging photometers that produced time-series CCD images. Light curves were constructed from the image time series and fit by least-squares methods with model light curves. A new modeling procedure is presented that allows a simultaneous fit of the atmospheric parameters for Pluto and the astrometric parameters for the occultation to all of the light curves. Under the assumption of a clear atmosphere and using this modeling procedure to establish the upper atmosphere boundary condition, immersion and emersion temperature profiles were derived by inversion of the Siding Spring light curve, which had our best signal-to-noise ratio. Above ∼1230 km radius, atmospheric temperatures are ∼100 K and decrease slightly with altitude–the same as observed in 1988 and 2002. Below 1210 km, the temperature abruptly decreases with altitude (gradients ∼2.2 K km^{-1}), which would reach the expected N_2 surface-ice temperature of ∼40 K in the 1158–1184 km radius range.

This structure is similar to that observed in 2002, but a much stronger thermal gradient (or stronger extinction) is implied by the 1988 light curve (which shows a "kink" or "knee" at 1210 km). The temperature profiles derived from inversion of the present data show good agreement with a physical model for Pluto's atmosphere selected from those presented by Strobel et al. (1996). Constraints derived from the temperature profiles (and considering the possibility of a deep troposphere) yield a value of 1152±32 km for Pluto's surface radius. This value is compared with surface-radius values derived from the series of mutual occultations and eclipses that occurred in 1985–1989, and the limitations of both types of measurements for determining Pluto's surface radius are discussed. The radius of Pluto's atmospheric shadow at the half-intensity point is 1207.9±8.5 km, the same as obtained in 2002 within measurement error. Values of the shadow radius cast by Pluto's atmosphere in 1988, 2002, and 2006 favor frost migration models in which Pluto's surface has low thermal inertia. Those models imply a substantial atmosphere when *New Horizons* flies by Pluto in 2015. Comparison of the shape of the stellar occultation light curves in 1988, 2002, and 2006 suggests that atmospheric extinction, which was strong in 1988 (15 months before perihelion), has been dissipating.

Published in: The Astronomical Journal, 234, 1 (2007 July)
For preprints, contact jle@mit.edu
or on the web at http://www.journals.uchicago.edu/AJ/journal/contents/v134n1.html

. . . . . .

Millisecond Dips in the RXTE/PCA Light Curve of Sco X-1 and Trans-Neptunian Object Occultation

H.-K. Chang[1,2], J.-S. Liang[1], C.-Y. Liu[2], and S.-K. King[3]

[1] Department of Physics, National Tsing Hua University, Hsinchu 30013, Taiwan

[2] Institute of Astronomy, National Tsing Hua University, Hsinchu 30013, Taiwan

[3] Institute of Astronomy and Astrophysics, Academia Sinica, Taipei 10617, Taiwan

Millisecond dips in the RXTE/Proportional Counter Array (PCA) light curve of Sco X-1 were reported recently, which were interpreted as the occultation of X-rays from Sco X-1 caused by trans-Neptunian objects (TNO) of 100-m size. Inconclusive signatures of possible instrumental effects in many of these dip events related to high-energy cosmic rays were later found and the TNO interpretation became shaky. Here, we report more detailed analysis aiming at distinguishing true occultation events from those related to cosmic rays. Based on some indicative criteria derived from housekeeping data and two-channel spectral information, we suggest that about 10% of the dips are probable events of occultation. The total number of TNOs of size from 60 to 100 m is estimated to be about 1015 accordingly. Limited by the coarser time resolution of standard data modes of RXTE/PCA, however, definite results cannot be obtained. Adequately configured observations with RXTE or other new instruments in the future are very much desired.

Published in: Monthly Notices of the Royal Astronomical Society, 378, 1287 (2007 July)
For preprints, contact hkchang@phys.nthu.edu.tw

. . . . . .

The Origin of the High-inclination Neptune Trojan 2005 TN_{53}

J. Li[1], L.-Y. Zhou[1], and Y.-S. Sun[1]

[1] Department of Astronomy, Nanjing University, Nanjing, PR China

Aims. We explore the formation and evolution of the highly inclined orbit of Neptune Trojan 2005 TN_{53}.

Methods. With numerical simulations, we investigated a possible mechanism for the origin of the high-inclination Neptune Trojans as captured into the Trojan-type orbits by an initially eccentric Neptune during its eccentricity damping and rapid inward migration, then migrating to the present locations locked in Neptune's 1:1 mean motion resonance.

Results. Two 2005 TN_{53}-type Trojans out of our 2000 test particles were produced with inclinations above 20°, moving on tadpole orbits librating around Neptune's leading Lagrange point.

Published in: Astronomy & Astrophysics, 464, 775 (2007 March)

. . . . . .

The Dust, Planetesimals and Planets of HD 38529

Amaya Moro-Martín[1], Renu Malhotra[2], John M. Carpenter[3], Lynne A. Hillenbrand[3], Sebastian Wolf[4], Michael R. Meyer[5], David Hollenbach[6], Joan Najita[7], and Thomas Henning[4]

[1] Department of Astrophysical Sciences, Peyton Hall, Ivy Lane, Princeton University, Princeton, NJ 08544, USA

[2] Department of Planetary Sciences, University of Arizona, 1629 E. University Boulevard, Tucson, AZ 85721, USA

[3] Department of Astronomy, California Institute of Technology, Pasadena, CA 91125, USA

[4] Max-Planck-Institut fur Astronomie, Königstuhl 17, 69117 Heidelberg, Germany

[5] Steward Observatory, University of Arizona, 933 North Cherry Ave., Tucson, AZ 85721, USA

[6] NASA Ames, Moffet Field, CA 94035, USA

[7] National Optical Astronomy Observatory, 950 North Cherry Ave., Tucson AZ 85721, USA

HD 38529 is a post-main sequence G8III/IV star (3.5 Gyr old) with a planetary system consisting of at least two planets having $M\sin i$ of 0.8 M_{Jup} and 12.2 M_{Jup}, semimajor axes of 0.13 AU and 3.74 AU, and eccentricities of 0.25 and 0.35, respectively. *Spitzer* observations show that HD 38529 has an excess emission above the stellar photosphere, with a signal-to-noise ratio (S/N) at 70 μm of 4.7, a small excess at 33 μm (S/N=2.6) and no excess <30 μm. We discuss the distribution of the potential dust-producing planetesimals from the study of the dynamical perturbations of the two known planets, considering in particular the effect of secular resonances. We identify three dynamically stable niches at 0.4–0.8 AU, 20–50 AU and beyond 60 AU. We model the spectral energy distribution of HD 38529 to find out which of these niches show signs of harboring dust-producing planetesimals. The secular analysis, together with the SED modeling results, suggest that the planetesimals responsible for most of the dust emission are likely located within 20–50 AU, a configuration that resembles that of the Jovian planets + Kuiper Belt in our Solar System. Finally, we place upper limits (8×10^{-6} lunar masses of 10 μm particles) to the amount of dust that could be located in the dynamically stable region that exists between the two planets (0.25–0.75 AU).

To appear in: Astrophysical Journal

For preprints, contact `amaya@astro.princeton.edu`

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

PAPERS RECENTLY SUBMITTED TO JOURNALS

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, MS6A2, 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, MS6A2, Fairfax, VA 22030, USA

Submitted to: The Astrophysical Journal

For preprints, contact `jwallin@gmu.edu`

or on the web at `http://arxiv.org/abs/0705.3408`

BOOKS

Two more chapters 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 and #52 of this newsletter.

. . . . . .

On the Atmospheres of Objects in the Kuiper Belt

S. Alan Stern[1] and Laurence M. Trafton[3]

[1] Space Science and Engineering Division, SwRI, 1050 Walnut Street, Suite 300, Boulder, CO 80302, USA

[2] Department of Astronomy, University of Texas, Austin, TX 78712, USA

Atmospheres around solar system bodies reveal key insights into the origins, chemistry, thermal evolution, and surface/interior interaction of their parent bodies. Atmospheres are also themselves of intrinsic interest for understanding the physics and chemistry of gaseous envelopes. Furthermore, atmospheres also reveal information about primordial nebular materials trapped in accreting bodies. For these reasons and others, the detection and study of atmospheres on objects in the Kuiper Belt (KB) is of interest. Here we review what is known about the atmosphere of both KBOs and planet Pluto; we then go on to more generally examine the source and loss processes relevant to KBO atmospheres, the likely kinds of vertical and horizontal structure of such atmospheres, and then briefly reflect on KBO atmospheric detection techniques.

For preprints, contact `Alan.Stern@nasa.gov`

. . . . . .

Physical Effects of Collisions in the Kuiper Belt

Z.M. Leinhardt[1], S.T. Stewart[1], and P.H. Schultz[2]

[1] Harvard University, USA

[2] Brown University, USA

Collisions are a major modification process over the history of the Kuiper Belt. Recent work illuminates the complex array of possible outcomes of individual collisions onto porous, volatile bodies. The cumulative effects of such collisions on the surface features, composition, and internal structure of Kuiper Belt Objects are not yet known. In this chapter, we present the current state of knowledge of the physics of cratering and disruptive collisions in KBO analog materials. We summarize the evidence for a rich collisional history in the Kuiper Belt and present the range possible physical modifications on individual objects. The question of how well present day bodies represent primordial planetesimals can be addressed through future studies of the coupled physical and collisional evolution of Kuiper Belt Objects.

Preprints available on the web at `http://arxiv.org/abs/0705.3943`

The *Distant EKOs* Newsletter is dedicated to provide researchers with easy and rapid access to current work regarding the Kuiper belt (observational and theoretical studies), directly related objects (e.g., Pluto, Centaurs), and other areas of study when explicitly applied to the Kuiper belt.

We accept submissions for the following sections:
⋆ Abstracts of accepted papers
⋆ Titles of submitted (but not yet accepted) papers and conference articles
⋆ Thesis abstracts
⋆ Short articles, announcements, or editorials
⋆ Status reports of on-going programs
⋆ Requests for collaboration or observing coordination
⋆ Table of contents/outlines of books
⋆ Announcements for conferences
⋆ Job advertisements
⋆ General news items deemed of interest to the Kuiper belt community

A LaTeX template for submissions is appended to each issue of the newsletter, and is sent out regularly to the e-mail distribution list. Please use that template, and send your submission to:

`ekonews@boulder.swri.edu`

The *Distant EKOs* Newsletter is available on the World Wide Web at:

`http://www.boulder.swri.edu/ekonews`

Recent and back issues of the newsletter are archived there in various formats. The web pages also contain other related information and links.

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`