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DISTANT EKOs
The Kuiper Belt Electronic Newsletter



Edited by: Joel Wm. Parker

ekonews@boulder.swri.edu

www.boulder.swri.edu/ekonews

CONTENTS

News & Announcements	2
Abstracts of 9 Accepted Papers	3
Title of 1 Submitted Paper	7
Title of 1 Other Paper of Interest	7
Conference Information	8
Job Announcements	9
Newsletter Information	11

NEWS & ANNOUNCEMENTS

The discovery that 2003 QY90 is a possible binary TNO was announced in by Elliot et al. in IAUC 8235. The object appears elongated in ground-based images (~ 0.5 arcsec seeing) taken over a 1.9 hour interval. Image analysis suggests two components of comparable brightness with separation of 0.34 ± 0.02 arcsec ($10,900 \pm 600$ km).

IAUC: <http://cfa-www.harvard.edu/iauc/08200/08235.html>

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If you were unable to attend the KBO occultation workshop at the DPS meeting, most of the presentations are available online at:

<http://www.its.caltech.edu/~asante/kbo.html>

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Recently, a couple readers submitted fascinating, pre-publication images of EKO's that may resolve some outstanding issues of the Kuiper belt (e.g., the bimodality of the color distribution and if there is an "edge" or not) and even show evidence of organic compounds. I have created a new webpage for such images if any other newsletter readers would like to submit their own:

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

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There were 9 new TNO discoveries announced since the previous issue of *Distant EKO's*:

2003 QW111, 2003 QX111, 2003 QY111, 2003 QZ111, 2003 QA112, 2003 QB112,
2003 QE112, 2003 UY117, 2003 UZ117

and 7 new Centaur/SDO discoveries:

2003 QC112, 2003 QD112, 2003 QN112, 2003 QP112, 2003 QM112, 2003 QO112,
2003 UA118

Reclassified objects:

2003 QA91 (TNO \rightarrow SDO)
2003 QY90 (TNO \rightarrow SDO)

Objects recently assigned numbers:

1999 OF4 = (66452)
1999 RZ253 = (66652)

Deleted/Re-identified objects:

2002 PP149 = 2000 QM252
2002 VQ94 removed from list of SDOs, now identified as C/2002 VQ94 (LINEAR)

Current number of TNOs: 728 (and Pluto & Charon, and 10 other TNO binary companions)

Current number of Centaurs/SDOs: 140

Current number of Neptune Trojans: 1

Out of a total of 869 objects:

437 have measurements from only one opposition
325 of those have had no measurements for more than a year
188 of those have arcs shorter than 10 days

(for more details, see: http://www.boulder.swri.edu/ekonews/objects/recov_stats.gif)

Properties of the Nuclei of Centaurs Chiron and Chariklo

O. Groussin¹, P. Lamy¹, and L. Jorda¹

¹ Laboratoire d'Astronomie Spatiale, BP8, 13376 Marseille Cedex 12, France

We analyze visible, infrared, radio and spectroscopic observations of 2060 Chiron in a synthetic way to determine the physical properties of its nucleus. From visible observations performed from 1969 to 2001, we determine an absolute V magnitude for the nucleus of 7.28 ± 0.08 with an amplitude of 0.16 ± 0.03 , implying a nearly spherical nucleus with a ratio of semi-axes $a/b = 1.16 \pm 0.03$. Infrared observations at 25, 60, 100 and 160 μm (i.e., covering the broad maximum of the spectral energy distribution) obtained with the Infrared Space Observatory Photometer (ISOPHOT) in June 1996 when Chiron was near its perihelion are analyzed with a thermal model which considers an intimate mixture of water ice and refractory materials and includes heat conduction into the interior of the nucleus. We find a very low thermal inertia of $3_{-3}^{+5} \text{ JK}^{-1} \text{ m}^{-2} \text{ s}^{-1/2}$ and a radius of 71 ± 5 km. Combining the visible and infrared observations, we derive a geometric albedo of 0.11 ± 0.02 . We find that the observed spectra of Chiron can be fitted by a mixture of water ice ($\sim 30\%$) and refractory ($\sim 70\%$) grains, and that this surface model has a geometric albedo consistent with the above value. We also analyze the visible, infrared and radio observations of Chariklo (1997 CU26) and derive a radius of 118 ± 6 km, a geometric albedo of 0.07 ± 0.01 and a thermal inertia of $0_{-0}^{+2} \text{ JK}^{-1} \text{ m}^{-2} \text{ s}^{-1/2}$. A mixture of water ice ($\sim 20\%$) and refractory ($\sim 80\%$) grains is compatible with the near-infrared spectrum and the above albedo.

To appear in: Astronomy & Astrophysics

For preprints, contact Olivier.Groussin@dlr.de

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Visible Spectroscopy of the Two Largest Known Trans-Neptunian Objects: Ixion and Quaoar

S. Marchi¹, M. Lazzarin¹, S. Magrin¹, and C. Barbieri¹

¹ Dipartimento di Astronomia, Università di Padova, Vicolo dell'Osservatorio 2, I-35122 Padova, Italy.

We report visible spectroscopy of the two largest known trans-Neptunian objects (TNOs): Quaoar (=50000) and Ixion (=28976) obtained respectively on 4th and 5th May 2003 with the ESO New Technology Telescope (NTT) at La Silla, Chile. The spectrum of Ixion is moderately red with an absorption feature around 0.80 μm , while Quaoar is a red object with a featureless spectrum. These differences seem to indicate differences in primordial composition or dynamical history, in spite of their present similar orbits.

Published in: Astronomy & Astrophysics, 408, L17 (2003 September)

For preprints, contact marchi@pd.astro.it

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Physical Survey of 24 Centaurs With Visible Photometry

James M. Bauer^{1,5}, Karen J. Meech¹, Yanga R. Fernández¹, Jana Pittichova¹,
Olivier R. Hainaut², Hermann Boehnhardt², and Audrey C. Delsanti^{3,4}

¹ Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA

² European Southern Observatory, Karl-Schwarzschild-Str. 2, 85748 Garching, Germany

³ European Southern Observatory, Sanitago de Chile, Chile

⁴ Observatoire de Paris-Meudon, 5 place Jules Janssen, 92195 Meudon Cedex, France

⁵ currently at: Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, MS 183-501, Pasadena, CA 91109, USA

We present optical observations of 24 Centaurs performed between 1998 and 2002 with the University of Hawaii 2.2-m telescope. This is the largest such Centaur survey to date. We report colors for all objects, and show that they cover a continuum with mean $V - R$ color of 0.58 ± 0.01 and standard deviation 0.15. The color distribution fits between those of the Kuiper Belt and the cometary nuclei, and seems consistent with the dynamical concept of the majority of Centaurs originating from the Kuiper Belt. We find no strong correlation between a Centaur's color and its orbital elements; there is at best a $< 3\sigma$ correlation with semimajor axis, with redder Centaurs being farther from the Sun. We have calculated the phase-darkening slope parameters G for 5 Centaurs, 4 of which are reported for the first time. They range from -0.18 to 0.13 . We have sufficient data to constrain the rotation periods of two Centaurs, 1999 UG₅ (which we reported earlier) and 1998 SG₃₅. We performed a comparison of the surface brightness profiles of 10 apparently-inactive Centaurs with point sources. We found no coma around these 10 objects, including C/LINEAR (2000 B4), and generally the upper limits to the dust mass loss rates are below 0.05 kg s^{-1} .

To appear in: Icarus

For preprints, contact `bauer@scn.jpl.nasa.gov`

A Search for Small Kuiper Belt Objects by Stellar Occultations

F. Roques¹, M. Moncuquet¹, N. Lavillonière¹, M. Auvergne¹, M. Chevreton¹,
F. Colas¹, and J. Lecacheux¹

¹ Observatoire de Paris, 92195 Meudon Cedex, France

We report the conditions and results of an observation campaign organized in 2000 September at the Pic du Midi Observatory, and dedicated for the first time to the study of Kuiper belt objects (KBOs) by stellar occultations. The observation consisted of recording the flux of a well-chosen star with a fast photometer (20 Hz) and counting occultations of this star by passing KBOs. The campaign provided 15 hr of good-quality signal (rms $\sigma \sim 1.8\%$) and zero detections of KBOs at a 4σ detection level. For a KBO differential size distribution assumed to vary as r^{-q} , this first result suggests a slope $q \lesssim 4.5$. A refined analysis of the data, studying diffraction patterns, allowed us to find an event at a 3σ detection level compatible with a 150 m KBO. More generally, observation campaigns of stellar occultation by KBOs on ≥ 2 m class telescopes could statistically constrain the slope and the expected turnover radius due to collisional erosion of the subkilometer KBO size distribution.

Published in: The Astrophysical Journal Letters, 594, L63 (2003 September 1)

For preprints, contact `Francoise.Roques@obspm.fr`

An Optical Survey of the Active Centaur C/NEAT (2001 T4)

James M. Bauer^{1,2}, Yanga R. Fernández¹, and Karen J. Meech¹

¹ Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA

² currently at: Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, MS 183-501, Pasadena, CA 91109, USA

We present the results of optical observations of C/NEAT (2001 T4), taken on 3 dates between October 2001 and September 2002, at the University of Hawaii 2.2 meter telescope. Coma was present for each observation, but the activity level was variable. We present surface brightness profiles, dust production rates and evidence for structure in the coma. There is a radial gradient in coma color, with the outer coma exhibiting the bluest colors. The object's $V - R$ and $R - I$ colors indicate that this is one of the reddest objects with a Centaur-type orbit.

Published in: Publications of the Astronomical Society of the Pacific, 115, 981

For preprints, contact `bauer@scn.jpl.nasa.gov`

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The Effect of Neptune's Accretion on Pluto and the Plutinos

Paul Wiegert¹, Kimmo Innanen², Tian-Yi Huang³, and Seppo Mikkola⁴

¹ Department of Physics, Queen's University, Kingston, ON K7L 3N6, Canada

² Department of Physics and Astronomy, York University, 4700 Keele Street, Toronto, ON M3J 1P3, Canada

³ Department of Astronomy, Nanjing University, 210093 Nanjing, China

⁴ Tuorla Observatory, University of Turku, Väisäläntie 20, 21500 Piikkiö, Finland

The peculiar relationship of Pluto to Neptune, its resonances and high eccentricity and inclination, have led to the theory that the relationship arose from the migration of the outer planets, particularly the outward migration of Neptune, during the early solar system. In support of this scenario is the fact that the formation of Neptune at its current location would have been complicated by long dynamical times and low densities in the solar nebula. Here we address the following questions: Though the formation of Neptune at its current location seems unfavorable, are there dynamical obstacles to the capture of Pluto and the Plutinos under this scenario? Or are there features of the Neptune-Pluto system that would allow us to preclude this possibility of Neptune forming near its current orbit? Levison & Stern have examined the effect of the purely gravitational interactions of the giant planets on Pluto and concluded that the most important dynamical aspects of the Neptune-Pluto system could be reproduced. The exception was the amplitude of the 3:2 resonant argument, which was found to be too large in their model. We performed simulations of the outer solar system that included a slowly accreting Neptune and found that the efficiency of capture of dynamically cold particles into the 3:2 resonance was increased by a factor of 3, and that the resonant argument was substantially decreased. However, further dissipation is still required to match all aspects of the Plutino population and to produce truly Pluto-like orbits. Given that cold initial conditions did not reproduce the observations completely, simulations of initially dynamically hot particles near the 3:2 resonance with Neptune were also examined. These results, though resulting from seemingly ad hoc starting conditions, are reported as they produce remarkably good matches with both the Plutino population and Pluto's own orbit, including all three of its known resonances. These simulations reveal that Pluto could have arisen from an initially low- e (~ 0) but high- i ($\sim 25^\circ$) orbit, both a clue to its origin and an illustration of the difficulty in understanding Pluto's current orbital configuration.

Published in: The Astronomical Journal, 126, 1575 (2003 September)

For preprints, contact `wiegert@astro.queensu.ca`

Dynamical Effects from Asteroid Belts for Planetary Systems

Ing-Guey Jiang¹ and Li-Chin Yeh²

¹ Institute of Astronomy, National Central University, Chung-Li, Taiwan

² Department of Mathematics, National Hsinchu Teachers College, Hsin-Chu, Taiwan

The orbital evolution and stability of planetary systems with interaction from the belts is studied using the standard phase-plane analysis. In addition to the fixed point which corresponds to the Keplerian orbit, there are other fixed points around the inner and outer edges of the belt. Our results show that for the planets, the probability to move stably around the inner edge is larger than the one to move around the outer edge. It is also interesting that there is a limit cycle of semi-attractor for a particular case. Applying our results to the Solar System, we find that our results could provide a natural mechanism to do the orbit rearrangement for the larger Kuiper Belt Objects and thus successfully explain the absence of these objects beyond 50 AU.

To appear in: International Journal of Bifurcation and Chaos

For preprints, contact jiang@astro.ncu.edu.tw

or on the web at <http://arXiv.org/abs/astro-ph/0309220>

The Resonant Dynamical Evolution of Small Body Orbits among Giant Planets

R. Gabryszewski¹ and I. Włodarczyk²

¹ Space Research Centre, ul. Bartycka 18 A, 00-716 Warszawa, Poland

² Astronomical Observatory of the Chorzów Planetarium, WPKiW, 41-501 Chorzów, Poland

Mean motion resonances (MMRs) can lead either to chaotic or regular motion. We report on a numerical experiment showing that even in one of the most chaotic regions of the Solar System, the region of the giant planets, there are numerous bands where MMRs can stabilize orbits of small bodies in a time span comparable to their lifetimes. Two types of temporary stabilization were observed: short period ($\sim 10^4$ years) when a body was in a MMR with only one planet and long period (over 10^5 years) when a body is located in overlapping MMRs with two or three planets. The experiment showed that the Main Belt region can be enriched by cometary material in its pre-active state due to temporary resonant interactions between small bodies and giant planets.

Published in: Astronomy & Astrophysics, 405, 1145 (2003 July)

For preprints, contact r.gabryszewski@cbk.waw.pl

Constraining Recovery Observations for Trans-Neptunian Objects with Poorly Known Orbits

Jeffrey D. Goldader¹ and Charles Alcock¹

¹ Dept. of Physics and Astronomy, University of Pennsylvania, 209 South 33rd Street, Philadelphia, PA 19104, USA

We present a simple method for constraining the possible future positions of distant solar system objects observed twice over only a very short time span. The method involves taking two positions and then determining a large number of possible orbits compatible with the observed motion across the sky for an object with unknown (but constrainable) distance from Earth. A key advantage of this approach is that it assumes only that the object is bound and distant. Monte Carlo techniques are used to incorporate astrometric uncertainty and map out the allowed orbital parameter space. The method allows us to compute the object's position on the selected recovery date for each potential orbit, assisting the selection of fields for recovery observations. Examples are shown, and usage of the code is discussed.

Published in: Publications of the Astronomical Society of the Pacific, 115, 1330 (2003 November)

For preprints, contact `jgoldad@physics.upenn.edu`

The source code is available at <http://www.astro.upenn.edu/projects/TNO/>

PAPERS RECENTLY SUBMITTED TO JOURNALS

Simultaneous Visible and Near-infrared Time-resolved Observations of the Outer Solar System Object (29981) 1999 TD₁₀
**B.E.A. Mueller¹, C.W. Hergenrother², N.H. Samarasinha¹,
H. Campins^{2,3}, and D.W. McCarthy, Jr.⁴**

¹ NOAO, Tucson AZ, USA

² LPL, Univ. of AZ, Tucson AZ, USA

³ Univ. of Central Florida, Orlando FL, USA

⁴ Steward Obs., Univ. of AZ, Tucson AZ, USA

Submitted to: Icarus

For preprints, contact `muller@noao.edu`

OTHER PAPERS OF INTEREST

The 3rd Zone: Exploring the Kuiper Belt

S.A. Stern¹

¹ SwRI, 1050 Walnut St., Suite 400, Boulder, CO. 80302, USA

Sky & Telescope, 106, 30 (2003 November)

For preprints, contact `astern@boulder.swri.edu`

CONFERENCE INFORMATION

The Edgeworth-Kuiper Belt: A View of the Solar System beyond Neptune

a session of the Asia-Oceania Geosciences Society Annual Meeting and Exhibition

2004 July 5-9

Suntec City, Singapore

<http://www.asiaoceania.org/proposals/sp/sp11.htm>

<http://www.asiaoceania.org/confer.html>

Only a theory ten years ago, the Edgeworth-Kuiper Belt is now a reality, with a continuously increasing number of discovered objects. The Kuiper Belt Objects are attracting a growing interest from a wide scientific community. They not only are thought to be the source of many short period comets, but also they should be formed by almost pristine materials, whose study is of extreme interest for the history of the solar system. Moreover, surprising differences exist between them, both from a dynamical and a spectroscopic point of view. The objective of this session is to give an outline of the current aspects of the research on KBOs. The session will be organized around the following topics: the dynamical picture of the outer solar system; the taxonomic populations (KBOs, Centaurs, comets); the observational techniques; thermal and structural evolution; surface properties; formation and evolution.

For more information contact:

Main Organiser

Maria Teresa Capria

CNR-IASF, Area di Ricerca di Tor Vergata, via del Fosso del Cavaliere, 00133 Rome, Italy

capria@rm.iasf.cnr.it

Co-Organisers

Daisuke Kinoshita (NAOJ) daisuke@chiron.mtk.nao.ac.jp

Antonella Barucci (LESIA-Observatoire de Paris) antonella.barucci@obspm.fr

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The 36th Annual DPS meeting

2004 November 8–12

Louisville, Kentucky, USA

<http://dps04.org/>

The Division for Planetary Sciences of the American Astronomical Society will hold its 36th Annual Meeting in Louisville, Kentucky November 8–12, 2004. Special features include a Sunday night reception at the Louisville Slugger Museum and a Wednesday night banquet at Churchill Downs, starting with a live race at the historic track. Groundbreaking new science is expected to be announced in Louisville from the recently arrived Cassini Mission to Saturn and Titan, the newly launched Space Infrared Telescope Facility (SIRTF), two recently landed Mars Exploration Rovers (MER), the just-returned Genesis solar-wind sample mission, and more. Local attractions include Fort Knox, Mammoth Cave National Park, Maker's Mark Distillery, My Old Kentucky Home State Park, the Kentucky Horse Park, the Falls of the Ohio State Park, and the new Muhammad Ali Center in downtown Louisville.

Contact information of LOC members is listed at: http://dps04.org/dps_people_loc.html

JOB ANNOUNCEMENTS

Astrobiology Postdoctoral Fellows University of Hawaii

The Institute for Astronomy (IfA) invites applications for postdoctoral fellows with a strong interest in astrobiology to collaborate with the University of Hawaii's NASA Astrobiology Institute lead team members. The UH lead team will maintain an innovative multi-disciplinary research environment linking biological, microbiological, chemical, geological and astronomical sciences to investigate the origin, history, distribution and role of water as it relates to life in the universe. The core of this program will center around interactions with an interdisciplinary group of postdoctoral fellows. Areas of primary research collaboration will be:

1. formation and measurement of astrobiologically important molecules such as sugars, amino acids, carboxylic acids, carbon homologues, hopanes, steranes, and head to head isoprenoids, as well as interpretation of the redox environment as it pertains to life in water-rich extraterrestrial ice analog samples;
2. star formation (IR spectroscopy of sources in and behind dark clouds, sub-mm interferometry of disks);
3. studies of small solar system primitive bodies (including both IR spectra, and isotopic studies);
4. modeling the incorporation of water into pre-planetary grains;
5. mineralogy, petrology and isotope (D/H) chemistry of aqueously-altered carbonaceous chondrites;
6. incorporation of water into planetary bodies, its cycling between surface and interior and its subsequent loss to space;
7. aqueous alteration on Mars;
8. evolution and diversity of microorganisms, especially those living in extreme and unusual Earth environments;
9. experimental and field investigation of indigenous microbiota and energetics of potential metabolic pathways in ocean crust and mantle rocks as analogs for early Earth habitats;
10. the ecology and biogeochemistry of extreme aqueous environments on the Earth, including subglacial lakes, high-altitude lakes and fumaroles as analogs to habitats elsewhere in the solar system;
11. the development of astrobiological instruments;
12. models of theoretical ocean-bearing extrasolar planets and their remote characterization; and
13. the development of collaborative multidisciplinary computing techniques.

Minimum qualifications include a Ph.D. and the expertise appropriate for the specific research focus selected by the applicant. This could include (but is not limited to):

- Expertise in infrared astronomical spectroscopy and research experience in star formation, circumstellar disks, or small solar system bodies
- Experience with astronomical sub-millimeter spectroscopy & interferometry
- Background in experimental physical chemistry (reaction dynamics, photo-chemistry, charged and neutral particle sources and high vacuum technology)
- Experience with solar nebula models
- Familiarity with basic analyses of seawater based fluids, microbial molecular genetic techniques, and thermodynamic modeling of fluid-rock solution systems;
- Strong research programming skills (Java/C++/other) with an interest in collaborative computing and/or artificial intelligence.

- Experience with scanning and transmission electron microscopy, electron and ion microprobes; experience in geo/cosmochemistry or physicochemistry.
- Experience in marine microbial ecology and biogeochemistry
- Molecular Biology and microbiology techniques
- Modeling of upper atmospheric chemistry and physics
- Analysis of remote sensing of terrestrial surface and atmosphere
- Experience in the design and construction of instrumentation

Additional desirable qualifications

- Education and public outreach is an integral part of the Astrobiology program and experience with or interest in E/PO will be considered positively in an application.

The successful candidates will have access to unequaled astronomical observing facilities at the Mauna Kea and Haleakala observatories, an Ultra-High Vacuum Surface scattering machine, a 5 spectrometer electron microprobe and scanning electron microscope, a prototype Cryobot, fully-equipped molecular biology and microbiology laboratories, the R/V Kilo Moana oceanographic research ship, and the University of Hawaii Undersea Research Laboratory. In addition, successful candidates will be in close proximity to a variety of unique aquatic habitats (open ocean, high-altitude lakes, fumaroles). Appointments will be up to 3 years assuming satisfactory progress. Fellows will receive a stipend of \$4,333 per mo, a relocation allowance and small research budget. Fellows may apply for an subsequent 2 year position as senior fellows.

Applicants are expected to propose a program of research in consultation with the lead team members. Please address application materials including a complete application form (available online at: <http://www.ifa.hawaii.edu/UHNAI/application.html>), which includes a CV, publication list, a research proposal describing connections to at least 2 lead team members (see <http://www.ifa.hawaii.edu/UHNAI>) and a list of at least three professional references to:

Dr. Rolf Kudritzki, Director
Institute for Astronomy
2680 Woodlawn Drive,
Honolulu, HI 96822

Request that the letters of recommendation are sent directly to this same address. Further details may be obtained from Dr. Rolf Kudritzki at 808-956-8566 or email kud@ifa.hawaii.edu. Questions about the UH Astrobiology lead team's program may be directed to Dr. K. J. Meech. Applications will be reviewed beginning Dec. 15, 2003, but the positions will remain open until filled. The University of Hawaii is an EEO/AA employer and encourages applications from women and minorities.

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^AT_EX 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 ... ??

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`