Issue No. 18 *July 2001*

DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

Another big TNO has been found: 2001 KX76. If it has an albedo of 4%, it may be slightly larger than Charon. If it has the same albedo as Varuna, it is slightly larger than Varuna. The IAU Circular describing photometric observations can be found at:

`http://cfa-www.harvard.edu/iauc/07600/07657.html`

More information and press releases:

`http://www.noao.edu/outreach/press/pr01/pr0110.html`

`http://news.bbc.co.uk/hi/english/sci/tech/newsid_1419000/1419508.stm`

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Observations with the Submillimeter Wave Astronomy Satellite (SWAS) have detected water vapor around the star IRC+10216. It is suggested that the water is from evaporated icy bodies, with an evaporation zone currently around 75 AU from the parent star. More information and press releases available at:

`http://sao-www.harvard.edu/swas/pr010711.html`

`http://www.washingtonpost.com/wp-dyn/articles/A46732-2001Jul11.html`

The abstract is included in this issue of the Newsletter.

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There were 49 new TNO discoveries announced since the previous issue of the *Distant EKOs* Newsletter (more than a 13% increase of the total number of TNOs in just 2 months!):

1999 RK257, 2000 OU69, 2000 QL251, 2000 QM251, 2000 QN251, 2001 DB106, 2001 DC106, 2001 DD106, 2001 ES24, 2001 HA59, 2001 HZ58, 2001 DR106, 2001 DS106, 2001 FB185, 2001 FC185, 2001 HY65, 1999 SA28, 2001 FK185, 2001 FL185, 2001 FM185, 2001 FN185, 2001 FO185, 2001 FQ185, 2001 FR185, 2001 FS185, 2001 FT185, 2001 FU185, 2001 FV185, 2001 KA77, 2001 KE76, 2001 KF76, 2001 KG76, 2001 KH76, 2001 KJ76, 2001 KK76, 2001 KL76, 2001 KM76, 2001 KN76, 2001 KO76, 2001 KP76, 2001 KQ76, 2001 KR76, 2001 KS76, 2001 KT76, 2001 KU76, 2001 KV76, 2001 KW76, 2001 KX76, 2001 KY76

and 8 new Centaur/SDO discoveries (a fractional increase in number comparable to that for the TNOs):

2001 FP185, 2001 KB77, 2001 KC77, 2001 KD77, 2001 KE77, 2001 KF77, 2001 KG77, 2001 KZ76

Object with new identification:
2000 FS53 = 1999 KS16

Objects recently assigned numbers:
1995 SM55 (24835)
1997 QJ4 (24952)
1998 HJ151 (24978)
1996 GQ21 (26181)
1998 SM165 (26308)
1999 DE9 (26375)

Current number of TNOs: 415 (and Pluto & Charon)
Current number of Centaurs/SDOs: 77

PAPERS ACCEPTED TO JOURNALS

The Size and Albedo of The Kuiper-belt Object (20000) Varuna

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Observations over the last decade have revealed the existence of a large number of bodies orbiting the Sun beyond Neptune. Known as the Kuiper-belt objects (KBOs), they are believed to be formed in the outer reaches of the protoplanetary disk around the young Sun, and have been little altered since then. They are probably the source of short-period comets. The KBOs are, however, difficult objects to study because of their distance from earth, so even basic physical properties such as their sizes and albedos remain unknown. Previous size estimates came from assuming an albedo with the canonical value being 0.04. Here we report simultaneous measurements of the thermal emission and reflected optical light of the bright KBO (20000) Varuna, which allow us to determine independently both the size and the albedo. Varuna has an equivalent circular diameter of $D = 900^{+129}_{-145}$ km and a red geometric albedo of $pR = 0.070^{+0.030}_{-0.017}$. Its surface is darker than Pluto's, suggesting that it is largely devoid of fresh ice, but brighter than previously assumed for KBOs.

Published in: Nature, 411, 446 (2001 May 24)

For preprints, contact `jewitt@ifa.hawaii.edu`

or on the web at `http://www.ifa.hawaii.edu/faculty/jewitt/varuna.html`

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Almost Planet X

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Optical and infrared observations of a bright object in the outer Solar System reveal it to be surprisingly large — almost as big as Pluto's moon. It could be the first of many such discoveries.

Published in: Nature, 411, 423 (2001 May 24)

For preprints, contact `stephen.tegler@nau.edu`

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The Radial Distribution of the Kuiper Belt

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We examine the radial distribution of the Kuiper Belt Objects (KBOs) using a method that is insensitive to observational bias effects. This technique allows the use of the discovery distances of all KBOs, independent of orbital classification or discovery circumstance. We verify the presence of an outer edge to the Kuiper Belt, as reported in other works, and we measure this edge to be at $R = 47 \pm 1$ AU given any physically plausible model of the size distribution. We confirm that this outer edge is due to the Classical KBOs, the most numerically dominant observationally. In addition, we find that current surveys do not preclude the presence of a second, unobserved Kuiper Belt beyond $R = 76$ AU.

Published in: The Astrophysical Journal, 554, L95 (2001 June 10)
For preprints, contact `chad@gps.caltech.edu`
or on the web at
`http://www.gps.caltech.edu/~chad/publications/2001-trujillo-brown.pdf`

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NICS-TNG Infrared Spectroscopy of Trans-neptunian Objects 2000 EB173 and 2000 WR106

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[1] Centro Galileo Galilei & Telescopio Nazionale Galileo, P.O. Box 565, E-38700, S/C de La Palma, Tenerife, Spain

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[3] Osservatorio Astronomico di Torino, I-10025 Pino Torinese, Italy

We report complete near-infrared (0.9–2.4 μm) spectral observations of trans-neptunian objects (TNOs) 2000 EB173 and 2000 WR106 collected using the new Near Infrared Camera Spectrometer (NICS) attached to the 3.56m Telescopio Nazionale Galileo (TNG). Both spectra are very red and with a quite strong and broad drop extending throughout the K band. However, while 2000 EB173 does not show any evidence of narrow absorption features, the spectrum of 2000 WR106 has quite deep water ice absorption at 1.5 and 2.0 μm. Moreover, the latter object is significantly less red than the former indicating, therefore, that the surface of 2000 WR106 is "cleaner" (i.e. less processed by particle irradiation) than that of 2000 EB173.

To appear in: Astronomy & Astrophysics
For preprints, contact `licandro@tng.iac.es`
or on the web at `http://www.arXiv.org/abs/astro-ph/0105434`

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Analysis of Trans-Neptunian and Centaur Colours: Continuous Trend or Grouping?

M.A. Barucci[1], M. Fulchignoni[1], M. Birlan[1], A. Doressoundiram[1], J. Romon[1], and H. Boehnhardt[2]

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We report the results of the first statistical analysis of colours ($B-V$, $V-R$, $V-I$, and $V-J$) of the Trans-Neptunian and Centaur populations. Using the same statistical techniques applied to define the current asteroid taxonomy, we find a continuous spread of the objects between neutral colour to very red. Pushing further the analysis, the TNOs may be split into four groups. The differences in colour content are interpreted as a consequence of the TNOs evolution (i.e. collisional history, space weathering, ...)

Published in: Astronomy and Astrophysics, 371, 1150 (2001 May)
For preprints, contact `antonella.barucci@obspm.fr`

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Colors and Spectra of Kuiper Belt Objects

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We present new measurements of the optical colors of Kuiper Belt Objects, principally from the Keck 10-m telescope. The measurements confirm the existence of a wide spread in the $B-V$, $V-R$, and $R-I$ color indices (Luu and Jewitt 1996). Relative to the Sun, the Kuiper Belt Objects exhibit reflected colors from nearly neutral to very red. The optical and optical-infrared ($V-J$) color indices are mutually correlated, showing the presence of a single reddening agent from 0.45μm to 1.2μm. On the other hand, we find no evidence for linear correlations between the color and absolute magnitude (a proxy for size), instantaneous heliocentric distance, semi-major axis, or with any other orbital property. In this regard, the Kuiper Belt Objects differ from the main-belt asteroids in which strong radial color gradients exist. We find no statistically significant evidence for bimodal or other non-uniform color distributions, either in our data, or in data previously reported to show such evidence. The impact resurfacing hypothesis is re-examined in the light of the new color data and is rejected as the primary cause of the observed color dispersion. We also present new near-infrared reflection spectra of 1993 SC, 1996 TS_{66}, 1999 DE_9 and 2000 EB_{173}, taken at the Keck and Subaru telescopes. These spectra, combined with others from the published literature, provide independent evidence for compositional diversity in the Kuiper Belt. Objects 2000 EB_{173}, 1993 SC, and 1996 TS_{66} are spectrally bland while 1999 DE_9 shows solid-state absorption bands.

To appear in: Astronomical Journal, in press
For preprints, contact `jewitt@ifa.hawaii.edu`
or on the web at `http://www.ifa.hawaii.edu/~jewitt/papers/COLORPAPER`

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Photometric Study of Centaurs 10199 Chariklo (1997 CU_{26}) and 1999 UG_5

N. Peixinho[1], P. Lacerda[2], J.L. Ortiz[3], A. Doressoundiram[4], M. Roos–Serote[1], and P.J. Gutiérrez[3]

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[2] Leiden Observatory, the Netherlands

[3] Instituto de Astrofísica de Andalucía, CSIC, Granada, Spain

[4] Paris–Meudon Observatory, France

We present the results of visible broad band photometry of two Centaurs, 10199 Chariklo (1997 CU_{26}) and 1999 UG_5, from data obtained at the 1.52 meter telescope of the National Astronomical Observatory at Calar Alto, Spain, during 2 separate runs in April 1999 and February 2000 and at the 1.5 meter telescope of the Sierra Nevada Observatory, Spain, in March of 1999.

For Chariklo, the absolute magnitudes determined from the February 2000 data are found to be higher by about 0.27 magnitudes than the average in the 1999 run. This may indicate long period rotational variability and possibly a G parameter higher than the assumed value of 0.15. From the best sampled R-lightcurve obtained in the February 2000 run, no short term rotational variability was found. The $V-R$ colours for this object in all runs are similar to previously published values. For 1999 UG_5, colours were found to be very red: $B-V = 0.88 \pm 0.18$, $V-R = 0.60 \pm 0.08$ and $R-I = 0.72 \pm 0.13$. These results place this object in the group of the reddest known bodies in the Solar System. H_R and H_V are found to be 10.06 ± 0.09 and 10.61 ± 0.07 respectively, and its diameter is estimated to be on the order of 47 ± 2 km.

Published in: Astronomy and Astrophysics, 371, 753 (2001 May)
For preprints, contact peixinho@oal.ul.pt

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The Rotation Axis of the Centaur 5145 Pholus

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We present observations of the Centaur 5145 Pholus from 2000 January to 2000 August. A rotational lightcurve was assembled from both V and R measurements, confirming previous period determinations of 0.416 day but exhibiting an amplitude over twice as high as previously measured. This lightcurve was then used in conjunction with previously published lightcurves to solve for a north pole position of $\lambda_0 = 149°$, $\beta_0 = +26°$ (prograde rotation) and a sidereal period of 0.4159256 ± 0.0000016 day. As part of this analysis, the axial ratios of Pholus were found to be $a/b = 1.8$ and $b/c = 1.0$. Color analyses of the data give an average $V-R$ color of 0.71 ± 0.03, which is slightly lower than the 0.75–0.84 range previously seen. This difference, combined with the fact that we see color variations as a function of rotation, suggest that Pholus' northern hemisphere contains bluer features than are seen in its southern hemisphere.

To appear in: Icarus
For preprints, contact: farnham@astro.as.utexas.edu
or on the web at: http://zinfandel.as.utexas.edu/~farnham/pubs.html

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Short Term Variability of Centaur 1999 UG_5

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A lightcurve of Centaur 1999 UG_5 from R-band CCD images taken at the Calar Alto 1.52 m and La Palma 3.5 m TNG telescopes is presented. The lightcurve shows noticeable changes in brightness. Small activity outbursts do not appear to be the cause of the brightness changes because no coma was detected after coadding all the images. Thus, the changes in brightness are interpreted as being caused by rotational variability. A periodogram analysis of the lightcurve reveals significant peaks from 13.0 h to 13.8 h, with a confidence level exceeding 99.9%. The maximum spectral power corresponds to 13.25 h. The overall shape of the lightcurve can be explained by an irregular object rotating once per 26.5 h, but other possibilities exist. Assuming an ellipsoid shape for the rotating body, the 0.24 ± 0.02 mag amplitude of the lightcurve implies a minimum axial ratio of 1.25. The mean absolute magnitude in V band was found to be $H_V = 10.42 \pm 0.02$ assuming a typical phase parameter $G = 0.15$. This implies a diameter of 55.3 km for the object, provided that a typical albedo of 0.04 is assumed. The colours of 1999 UG_5 were found to be $B - V = 0.95 \pm 0.13$, $V - R = 0.63 \pm 0.06$, and $R - I = 0.61 \pm 0.09$.

Published in: Astronomy and Astrophysics, 371, L1 (2001 May)

For preprints, contact `pedroj@iaa.es`

or on the web at

`http://www.edpsciences.fr/articles/aa/abs/2001/19/aadb271/aadb271.html`

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Search for CO Gas in Pluto, Centaurs and Kuiper Belt Objects at Radio Wavelengths

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[4] Division of Physics, Mathematics and Astronomy, California Institute of Technology, MS 320-47, Pasadena, CA 91125, USA

We have searched for several rotational lines of CO in the Pluto-Charon system, Centaurs (Chiron, Pholus, Nessus, Asbolus, Chariklo and 1998 SG35) and Kuiper Belt objects (1994 TB, 1996 TL66, 1996 TO66, 1996 TP66 and 1998 WH4). The observations were performed with the 30 m telescope of the Institut de Radioastronomie Millimétrique for Pluto/Charon, and with the James Clerk Maxwell Telescope and Caltech Submillimeter Observatory for Centaurs and Kuiper Belt objects. A tentative 4.5-σ J(2-1) CO line is present in the Pluto/Charon spectrum, which requires further confirmation. Assuming that Charon does not contribute to the CO emission, an upper limit of 1.2% and 7% is obtained for the CO/N_2 mixing ratio in Pluto's atmosphere, using the atmospheric thermal structure derived from the Stansberry et al. (1994, Icarus 111, 503) and

Strobel et al. (1996, Icarus 120, 266) models, respectively. These upper limits are more constraining (by more than a factor of 6) than the upper limits reported by Young et al. (2001, Icarus, in press) from near-IR spectroscopy. None of the Centaurs or Kuiper Belt objects (KBO) were detected in CO. The CO production rate upper limit obtained for Chiron (3–5 $\times 10^{27}$ mol s^{-1}) over 1998–2000 years is a factor of 10 lower than the CO production rate derived from the marginal CO detection obtained in June 1995 by Womack & Stern (1999, Astron. Vestnik 33, 216), using same modelling of CO emission. Upper limits obtained for other Centaurs are typically $\sim 10^{28}$ mol s^{-1}, and between 1 and 5 $\times 10^{28}$ mol s^{-1} for the best observed KBOs. The comparison between these upper limits and the CO outgassing rates of comet C/1995 O1 (Hale-Bopp) measured at large distances from the Sun shows that Centaurs and KBOs underwent significant CO-devolatilization since their formation.

To appear in: Astronomy & Astrophysics
For preprints, contact dominique.bockelee@obspm.fr

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Discovery of Water Vapor Around IRC+10216 as Evidence for Comets Orbiting Another Star

Gary J. Melnick[1], David A. Neufeld[2], K.E. Saavik Ford[2], David J. Hollenbach[3], and Matthew L.N. Ashby[1]

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[3] NASA/Ames Research Center, Moffett Field, California 94035, USA

Since 1995, planets with masses comparable to that of Jupiter have been discovered around approximately 60 stars. These planets have not been seen directly, but their presence has been inferred from the small reflex motions that they gravitationally induce on the star they orbit; these motions result in small periodic wavelength shifts in the stellar spectrum. The presence of analogues of the smaller bodies in our Solar System cannot, however, be determined using this technique, because the induced reflex motions are too small-so an alternative approach is needed. Here we report the observation of circumstellar water vapour around the ageing carbon star IRC+10216; water is not expected in measurable quantities around such a star. The only plausible explanation for this water is that the recent evolution of IRC+10216, which has been accompanied by a prodigious increase in its luminosity, is causing the vaporization of a collection of orbiting icy bodies-a process considered in an earlier theoretical study.

Published in: Nature, 412, 160 (2001 July 12)
For preprints, contact gmelnick@cfa.harvard.edu
or on the web at http://sao-www.harvard.edu/swas/pr010711.html

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Orbital Evolution of Scattered Planets

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A simple dynamical model is employed to study the possible orbital evolution of scattered planets and phase plane analysis is used to classify the parameter space and solutions. Our results reconfirm that there is always an increase in eccentricity when the planet was scattered to migrate outward when the initial eccentricity is zero. Applying our study on the Solar System and considering the existence of the Kuiper Belt, this conclusion implies that Neptune was dynamically coupled with the Kuiper Belt in the early phase of the Solar System, which is consistent with the simulational model in Thommes, Duncan & Levison (1999).

To appear in: The Astrophysical Journal

For preprints, contact `jiang@asiaa.sinica.edu.tw`

or on the web at `http://www.arXiv.org/abs/astro-ph/0107038`

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The Effects of a Stellar Encounter on a Planetesimal Disk

Hiroshi Kobayashi[1] **and Shigeru Ida**[1]

[1] Department of Earth and Planetary Sciences, Tokyo Institute of Technology 2-12-1 Ookayama, Meguro, Tokyo 152-8551, Japan

We investigate the effects of a passing stellar encounter on a planetesimal disk through analytical calculations and numerical simulations, and derive the boundary radius ($a_{\rm planet}$) outside which planet formation is inhibited by disruptive collisions with high relative velocities. Ida, Larwood, and Burkert (2000. ApJ. 528, 1013–1025) suggested that a stellar encounter caused inhibition of planet formation in the outer part of a protoplanetary disk. We study orbital eccentricity (e) and inclination (i) of planetesimals pumped up by perturbations of a passing single star. We also study the degree of alignment of longitude of pericenter and ascending node to estimate relative velocities between the planetesimals. We model a protoplanetary system as a disk of massless particles circularly orbiting a host star, following Ida *et al.* (2000). The massless particles represent planetesimals. A single star as massive as the host star encounters the protoplanetary system. Numerical orbital simulations show that in the inner region at semimajor axis $a \lesssim 0.2D$ where D is pericenter distance of the encounter, e and i have power-law dependence on (a/D) as $e \propto (a/D)^{5/2}$ and $i \propto (a/D)^{3/2}$ and the longitudes are aligned, independent of the encounter parameters. In the outer region $a \gtrsim 0.2D$, the radial gradient is steeper, and is not expressed by a single power-law. The longitudes are not aligned. Since planet accretion is inhibited by e as small as 0.01, we focus on the weakly perturbed inner region. We analytically reproduce the power-law dependence and explicitly give numerical factors of the power-law dependence as functions of encounter parameters. We derive the boundary radius ($a_{\rm planet}$) of planet forming region as a function of dynamical parameters of a stellar cluster, assuming the protoplanetary system belongs to the stellar cluster. Since the radial gradient of e is so steep that the boundary is sharply determined. Planetesimal orbits are significantly modified beyond the boundary, while they are almost intact inside the boundary. This tendency is strengthened by reduction of relative velocity due to the longitude alignment in the inner region. We find $a_{\rm planet} \sim$ 40–60AU in the case of $D \sim$ 150–200 AU. $D \sim$ 200 AU may be likely to occur in a relatively dense cluster. We point out that the size of planetary systems ($a_{\rm planet}$)

born in a dense cluster may be necessarily restricted to that comparable to the size of planet region ($\sim$ 30–40 AU) of our Solar system.

To appear in: Icarus
For preprints, contact hkobayas@geo.titech.ac.jp
or on the web at
http://www.geo.titech.ac.jp/nakazawalab/hkobayas/paper/preprint.html

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PAPERS RECENTLY SUBMITTED TO JOURNALS

Properties of the Nucleus of 2060 Chiron and Chariklo (1997 CU26) from Visible, Infrared, Radio and Spectroscopic Observations

O. Groussin[1], P. Lamy[1], S. Peschke[2], and L. Jorda[1,3]

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[2] ESA-VILSPA, P.O. Box 50727, 28080 Madrid, Spain

[3] Max-Planck-Institut für Aeronomie, Postfach 20, D-37189 Katlenburg-Lindau, Germany

Submitted to: Icarus

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CONFERENCE CONTRIBUTIONS

Middle Ultraviolet Spectroscopy of Pluto and Charon

V.A. Krasnopolsky[1]

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Published in: American Geophysical Union, Spring Meeting 2001, abstract #P22B-06

For preprints, contact vkrasn@altavista.com

Abstract:
http://adsabs.harvard.edu/cgi-bin/nph-bib_query?bibcode=2001AGUSM...P22B06K

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Why We Need Detailed Visible-range Spectral Data on Kuiper Belt Objects?

V.V. Busarev[1]

[1] Sternberg State Astronomical Institute, Moscow University

Published in: American Astronomical Society Meeting 198, abstract #70.05

For preprints, contact busarev@sai.msu.ru

Abstract: http://www.aas.org/publications/baas/v33n2/aas198/186.htm

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Persephone: A Non-Nuclear Rendezvous Mission to a Kuiper Belt Object

G.L. Matloff[1]

[1] New York University, NY, USA

Published in: AIP Conference Proceedings, 552, 612 (2001 February)

CONFERENCE INFORMATION

33rd Lunar and Planetary Science Conference

March 4–8, 2002
Houston, Texas, USA

`http://www.lpi.usra.edu/meetings/33rdlpsc.html`

The next Lunar and Planetary Science Conference will be held March 4–8, 2002. This is approximately two weeks earlier than usual, and will necessitate an earlier abstract deadline of December 5, 2001. Also, due to the increase in numbers of submissions over the years, there will be a limit of TWO submissions per first author, including oral, poster, or print-only abstracts, but not counting an invited talk. Full details can be found on the website.

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Asteroids, Comets, Meteors — ACM2002

July 29 – August 2, 2002
Berlin, Germany

`http://earn.dlr.de/ACM2002`

The Conference will take place on the campus of the Technical University (TU-Berlin), located in the centre of Berlin. Further information will be provided in the second announcement, and on the web page `http://earn.dlr.de/ACM2002`. In order to estimate the number of participants and to update our mailing list we would appreciate receiving your response by filling out the on-line form. Please forward this message to other people you feel could be interested in the meeting.

We are looking forward to seeing you in Berlin.
Gerhard Neukum
Uri Carsenty
Gerhard Hahn
on behalf of the Local Organizing Committee

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`