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DISTANT EKO_s 
The Kuiper Belt Electronic Newsletter

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NEWS & ANNOUNCEMENTS

Dr. Carl Pilcher, Science Director for Exploration of the Solar System in NASA's Office of Space Science, announces the first issue of the new Solar System Exploration newsletter. It is online at <http://sse.jpl.nasa.gov/results/newsletter/newslet.html> in PDF format. The newsletter will be published several times a year to keep the planetary science community informed about activities and plans at NASA Headquarters, and to facilitate dialog. They invite your feedback; you can e-mail comments and suggestions to cpilcher@hq.nasa.gov or Ronald.S.Saunders@jpl.nasa.gov

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In case you missed it, the Scattered Disk Objects (SDOs) were recently moved from the TNO list to the Centaur list at the Minor Planet Center. This shift includes the following objects:

1995 TL8, 1996 TL66, 1998 XY95, 1999 CF119, 1999 CG119, 1999 CV118, 1999 CY118,
1999 CZ118, 1999 DG8, 1999 DP8, 1999 HW11, 1999 RD215, 1999 RE215, 1999 RJ215,
1999 RU214, 1999 RZ214, 1999 RZ215, 1999 TD10

Since then, a number of new probable SDOs have been added to those lists as well. The object lists and plots on the *Distant EKOs* website (e.g., <http://www.boulder.swri.edu/ekonews/objects/>) have been modified to reflect this classification change. The orbital characteristics that define SDOs versus TNOs or Centaurs are not unambiguously established (there is clearly a grey area where there is some overlap), so the division used on the *Distant EKOs* webpages is not definitive.

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There were 45 new TNO discoveries announced since the previous issue of the *Distant EKOs* Newsletter:

1999 RC216, 2000 CL104, 2000 CM104, 2000 CN104, 2000 CP104, 2000 CQ104, 2000 CE105,
2000 CF105, 2000 CG105, 2000 CH105, 2000 CJ105, 2000 CK105, 2000 CL105, 2000 CM105,
2000 CN105, 2000 CO105, 2000 CQ105, 2000 CS105, 2000 CY105, 2000 FA8, 2000 FB8,
2000 FC8, 2000 FD8, 2000 FE8, 2000 FF8, 2000 FG8, 2000 FH8, 2000 FR53, 2000 FS53,
2000 FT53, 2000 GV146, 2000 GW146, 2000 GX146, 2000 GY146, 2000 GZ146, 2000 FU53,
2000 FV53, 2000 FW53, 2000 FX53, 2000 FY53, 2000 GE147, 2000 GF147, 2000 GK147,
2000 GL147, 2000 GM147

and 6 new Centaur/SDO discoveries:

2000 CO104, 2000 CP105, 2000 CR105, 2000 EC98, 2000 GM137, 2000 FZ53

Current number of TNOs: 270 (and Pluto & Charon)

Current number of Centaurs/SDOs: 42

Visible and Infrared Photometry of Fourteen Kuiper Belt Objects

**John K. Davies¹, Simon Green², Neil McBride², Erica Muzzerall¹, David J. Tholen³,
Robert J. Whiteley³, Michael J. Foster², and Jon K. Hillier²**

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We present V–J colors of 14 Kuiper Belt objects using new infrared (J) data combined, in most cases, with simultaneous visible (V) data. We confirm the V–J vs absolute magnitude relation reported by Jewitt & Luu (1998) for the five objects in their dataset but demonstrate that the relationship does not hold for a larger sample. Kuiper Belt objects exhibit a wide range of V–J colors but there is no correlation with heliocentric distance or orbital class. The bi-modality seen in BVR colors by Tegler & Romanishin (1998) is not present in optical-infrared colors.

To appear in: Icarus

For preprints, contact `j.davies@jach.hawaii.edu`

or by anonymous ftp to `ftp.jach.hawaii.edu/pub/ukirt/jkd/v-j/v-j.ps`

or on the web at `http://www.jach.hawaii.edu/JACpublic/UKIRT/public/research.html`

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Detection of Carbon Monoxide in (2060) Chiron

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2060 Chiron is among the small population of large, outer Solar System objects called Centaurs. Chiron's unusual, 51-year orbit ranges in distance from 8.5 to just over 19 AU, and exhibits an inclination to the ecliptic plane of 8.5° . Recent dynamical studies (Levison and Duncan 1994; Dones et al. 1996) show this orbit is unstable to giant-planet perturbations on timescales of $< 10^6$ years, indicating that it is a recent addition to the planetary region. This, along with its low-inclination orbit, and its size similarity to the newly-discovered population of 100–400 km diameter Kuiper Disk objects (Campins et al. 1994; Jewitt and Luu 1995), provides strong circumstantial evidence that Chiron is an escaped object from the Kuiper Disk. Chiron's present orbit subjects it to much more intense insolation than objects in the Kuiper Disk experience. That insolation generates surface activity, as revealed by a highly variable coma (Hartmann et al. 1989; Meech and Belton 1990; Bus et al. 1993). The source of Chiron's activity has been speculated on for many years (Stern 1989) but never observationally identified. We report here the detection of CO molecules in Chiron's coma, which are probably the sublimation agent generating Chiron's activity.

Published in: Solar System Research (Astronomicheskii Vestnik), 33, 187 (1999)

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

or on the web at `http://www.boulder.swri.edu/~alan/papers/chiron_co.ps`

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The Formation of Uranus and Neptune in the Jupiter-Saturn Region of the Solar System

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Planets are believed to have formed through the accumulation of a large number of small bodies. In the case of the gas-giant planets Jupiter and Saturn, they accreted a significant amount of gas directly from the protosolar nebula after accumulating solid cores of about 5–15 Earth masses. Such models, however, have been unable to produce the smaller ice giants Uranus and Neptune at their present locations, because in that region of the Solar System the small planetary bodies will have been more widely spaced, and less tightly bound gravitationally to the Sun. When applied to the current Jupiter-Saturn zone, a recent theory predicts that, in addition to the solid cores of Jupiter and Saturn, two or three other solid bodies of comparable mass are likely to have formed. Here we report the results of model calculations that demonstrate that such cores will have been gravitationally scattered outwards as Jupiter, and perhaps Saturn, accreted nebular gas. The orbits of these cores then evolve into orbits that resemble those of Uranus and Neptune, as a result of gravitational interactions with the small bodies in the outer disk of the protosolar nebula.

Published in: Nature, 402, 635 (1999 December 9)

For preprints, contact duncan@astro.queensu.ca

or on the web at <http://www.astro.queensu.ca/~thommes/402635A0.pdf>

Pluto's Non-isothermal Surface

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We report on repeated far-infrared photometric observations of the Pluto-Charon system conducted in 1997 with the Infrared Space Observatory (ISO). These observations have led to the first detection of the system at 150 and 200 μm and to the first clear detection of its thermal lightcurve at 60 μm (and more marginally at 100 μm). They definitely prove that Pluto's surface is not isothermal. The thermal lightcurve is, as expected, roughly anticorrelated with the visible lightcurve, but not exactly. The data are fit by physical models including Charon and three separate units on Pluto, respectively dominated by (1) N_2 ice, (2) CH_4 ice, and (3) tholins. These models are constructed in accordance with information from visible imaging and lightcurve, visible spectroscopy and infrared spectroscopy, considerations on the thermal balance of N_2 and CH_4 , and include a thermophysical description of subsurface conduction and infrared beaming. Charon's contribution, which cannot be separated from Pluto's in the observations, is assumed to be independent of longitude and equivalent to that of a ~ 52 K body. The main implications are that Pluto's surface in units 2 and 3 has a thermal inertia $\Gamma = (1.5\text{--}10)\times 10^4 \text{ erg cm}^{-2} \text{ s}^{-1/2} \text{ K}^{-1}$, comparable to that of other icy satellites, and relatively high bolometric emissivities (not lower than 0.5 and most likely 0.8–1). Diurnal temperature variations must be significant, with maximum dayside temperatures in the

range 54–63 K. The value of thermal inertia may be indicative of porosity in the top centimeters of Pluto’s surface. The observations further confirm that the far-IR brightness temperatures, though somewhat smaller than indicated by IRAS, are higher than in the millimeter/submillimeter range. Extending the models to longer wavelengths suggests that a low radio emissivity, as opposed to a mixing of temperatures or a subsurface sounding effect, is the correct explanation. Finally, in spite of large error bars, the 150 μm fluxes indicated by ISO seem unexpectedly high given the spectral properties of ices in the far-IR. These, and the expected lightcurves of the Pluto-Charon system at $\lambda = 15\text{--}60 \mu\text{m}$ should be priority measurements for SIRTf.

To appear in: Icarus

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Nereid Has Complex Large-Amplitude Photometric Variability (Due to Chaotic Rotation)

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We report on 224 photometric measurements of Nereid, a small outer satellite of Neptune with a 360-day orbit of high eccentricity (0.751). Our photometry covers 64 nights from 1987 to 1997 and is primarily in the V -band, although we also have 20 measurements in the U , B , R , and I bands. (1) Nereid displays large-amplitude brightness variations with a total amplitude of 1.83 magnitude on time scales ranging from a few hours to roughly a year. (2) During the 12 days of the Voyager encounter with Neptune, Nereid did not display any short-term variations, however large-amplitude long-term variations could easily be hidden by the large phase effects and the short duration of observation. (3) Nereid’s variability is caused by high contrast albedo features, i.e. a dark hemisphere, along with rotational modulation. (4) The character of the brightness variations changed around 1991 from fast and large-amplitude to comparatively slow and low-amplitude. This demonstrates that the direction and magnitude of Nereid’s rotational angular momentum vector is changing on time scales comparable to its orbital period. (5) Large changes in the magnitude and direction of Nereid’s angular momentum vector are predicted to arise from chaotic rotation during every periapse passage provided that Nereid is more than $\sim 1\%$ nonspherical and is spinning slowly. The match between prediction and observation could be taken as strong evidence for chaotic rotation of Nereid. However, the intranight variability cannot be readily explained by chaotic rotation. (6) The colors of Nereid are $U - V = 0.84 \pm 0.05$, $B - V = 0.71 \pm 0.04$, $V - R = 0.44 \pm 0.03$, $V - I = 0.72 \pm 0.05$, and $V - K = 1.6$, indicating a nearly flat reflectance spectrum from 0.36 to 2.2 μm . We identify asteroids, inner satellites, and centaurs with similar spectra. (7) Nereid is likely either an inner moon of Neptune kicked to its current orbit or a captured Kuiper Belt object or Centaur, with the latter possibility being strongly preferred.

To appear in: Icarus

For preprints, contact schaefer@grb2.physics.yale.edu

or on the web at <http://xxx.lanl.gov/abs/astro-ph/0005050>

PAPERS RECENTLY SUBMITTED TO JOURNALS

Failed Oort Clouds and Planetary Migration

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Submitted to: The Astrophysical Journal Letters

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or on the web at <http://xxx.lanl.gov/abs/astro-ph/0004058>

OTHER PAPERS

Chiron

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Published in: The Encyclopaedia of Astronomy and Astrophysics

For preprints, contact joel@boulder.swri.edu

or by anonymous ftp to [ftp.boulder.swri.edu/pub/joel/chiron_enc.ps.gz](ftp://ftp.boulder.swri.edu/pub/joel/chiron_enc.ps.gz)

or on the web at <http://www.boulder.swri.edu/~joel/papers.html>

CONFERENCE CONTRIBUTIONS

Below is the list of the few Kuiper Belt-related papers I gleaned from the program for the 196th Meeting of the American Astronomical Society (2000 June 4-8, Rochester, NY, USA):

- Session 4. **Young Stars and Their Environments**, poster session, Mon, June 5
 - *2MASS-IRAS Newly Discovered Exozodiacal Vega-type Dust*
S.B. Fajardo-Acosta, C.A. Beichman, and R.M. Cutri
(abstract #4.09, <http://www.aas.org/publications/baas/v32n2/aas196/312.htm>)
 - Session 12. **Amateur-Professional Collaboration in Astronomy**, 10:00, Mon, June 5
 - *Pinning Down the Orbits of Transneptunian Objects*
B.G. Marsden and W.B. Offutt
(abstract #12.01, <http://www.aas.org/publications/baas/v32n2/aas196/121.htm>)
 - Session 36. **Exploring Dust and the ISM with SIRTf**, 8:30, Wed, June 7
 - *Dust Distribution in Zodiacal Clouds*
S.F. Dermott
(abstract #36.02, <http://www.aas.org/publications/baas/v32n2/aas196/91.htm>)
 - *Circumstellar Debris Disks and SIRTf*
D.E. Backman
(abstract #36.03, <http://www.aas.org/publications/baas/v32n2/aas196/101.htm>)
 - Session 52. **Ground Based Instrumentations**, poster session, Thu, June 8
 - *A Near Infrared Integral-Field Spectrograph for the Keck Adaptive Optics System*
M. Barczys, J.E. Larkin, A. Quirrenbach, and J.R. Graham
(abstract #52.06, <http://www.aas.org/publications/baas/v32n2/aas196/258.htm>)
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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^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.

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Moving ... ??

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