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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

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NEWS & ANNOUNCEMENTS

Having completed its successful flyby of the Pluto system, the New Horizons spacecraft is on a trajectory to encounter Kuiper Belt Object 2014 MU69. Pending NASA approval for an extended mission, New Horizons will also take advantage of being an observing platform in the outer solar system to observe a select number of other KBOs having favorable geometries for resolved or high signal-to-noise measurements.

Earth-based observations can support these pending New Horizons measurements through calibrated photometry at low phase angle (Earth), which will be complementary to the higher phase angle data from the spacecraft. In particular for objects having the potential for resolved imaging from the spacecraft, knowledge of the rotational phase at the time of the New Horizons observations can help constrain the overall shape of these distant objects.

An Earth-based campaign website in support of the pending science from the New Horizons extended mission is under construction `http://www.boulder.swri.edu/nh-support-obs/kbo` . Available there now is a table listing the pending targets having the highest priority for supporting observations. Register on that page to indicate interest.

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There were 4 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2012 HE85, 2015 BZ517, 2015 QT11, 2015 SP21

and 4 new Centaur/SDO discoveries:

2015 KH162, 2015 PK312, 2015 SO21, 2016 AE193

Reclassified objects:

2016 AE193 (SDO → Centaur)
2001 OO108 (TNO → SDO)
2002 PR170 (TNO → SDO)

Objects recently assigned numbers:

2013 XZ8 = (459865)
2014 AT28 = (459870)
2014 ON6 = (459971)
1999 OM4 = (455171)
2001 FE193 = (455206)
2001 KT76 = (455209)
2003 UZ413 = (455502)
2007 TH422 = (456826)

Objects recently assigned names:

2012 BX85 = Praamzius

Current number of TNOs: 1453 (including Pluto)
Current number of Centaurs/SDOs: 489
Current number of Neptune Trojans: 12

Out of a total of 1954 objects:
659 have measurements from only one opposition
639 of those have had no measurements for more than a year
328 of those have arcs shorter than 10 days
(for more details, see: `http://www.boulder.swri.edu/ekonews/objects/recov_stats.jpg`)

PAPERS ACCEPTED TO JOURNALS

The Long-wavelength Thermal Emission of the Pluto-Charon System from *Herschel* Observations. Evidence for Emissivity Effects

E. Lellouch[1], P. Santos-Sanz[2], S. Fornasier[1], T. Lim[3], J. Stansberry[4], E. Vilenius[5,6], Cs. Kiss[7], T. Müller[6], G. Marton[7], S. Protopapa[8], P. Panuzzo[9], and R. Moreno[1]

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Thermal observations of the Pluto-Charon system acquired by the *Herschel* Space Observatory in February 2012 are presented. They consist of photometric measurements with the PACS and SPIRE instruments (nine visits to the Pluto system each), covering six wavelengths from 70 to 500 μm altogether. The thermal light curve of Pluto-Charon is observed in all filters, albeit more marginally at 160 and especially 500 μm. Putting these data into the context of older ISO, *Spitzer* and ground-based observations indicates that the brightness temperature (T_B) of the system (rescaled to a common heliocentric distance) drastically decreases with increasing wavelength, from $\sim$53 K at 20 μm to $\sim$35 K at 500 μm, and perhaps even less at longer wavelengths. Considering a variety of diurnal and/or seasonal thermophysical models, we show that T_B values of 35 K are lower than any expected temperature for the dayside surface or subsurface of Pluto and Charon, implying a low surface emissivity. Based on multiterrain modeling, we infer a spectral emissivity that decreases steadily from 1 at 20-25 μm to $\sim$0.7 at 500 μm. This kind of behavior is usually not observed in asteroids (when proper allowance is made for subsurface sounding), but is found in several icy surfaces of the solar system. We tentatively identify that a combination of a strong dielectric constant and a considerable surface material transparency (typical penetration depth $\sim$1 cm) is responsible for the effect. Our results have implications for the interpretation of the temperature measurements by REX/*New Horizons* at 4.2 cm wavelength.

To appear in: Astronomy & Astrophysics

Preprints available on the web at `http://arxiv.org/abs/1601.05606`

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Observational Constraint on Pluto's Atmospheric CO with ASTE

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To confirm the previous observational results of Pluto's atmospheric CO in the $J = 2$-1 rotational transition, we conducted a new observation of CO ($J = 3$-2) in Pluto's atmosphere in 2014 August with the Atacama Submillimeter Telescope Experiment 10 m single-dish telescope. In contrast to the previous observational result obtained with the James Clerk Maxwell Telescope in 2009 and 2010 by using the $J = 2$-1 transition, no emission structure was observed near the rest frequency in our attempt. Possible explanations for the nondetection result of the $J = 3$-2 transition are discussed.

Published in: Publications of the Astronomical Society of Japan, 68, L1

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Dynamical and Collisional Evolution of Kuiper Belt Binaries

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We present numerical simulations of the evolution of synthetic Trans-Neptunian Binaries (TNBs) under the influence of the solar perturbation, tidal friction, and collisions with the population of Classical Kuiper Belt Object (KBOs).

We show that these effects, acting together, have strongly sculpted the primordial population of TNBs. If the population of Classical KBOs have a power law size distribution as the ones that are inferred from recent observational surveys (Petit et al. 2011, Adams et al. 2014, Fraser at al. 2014), the fraction of surviving binaries at present would be ∼70% of the primordial population. The orbits of the surviving synthetic systems match reasonably well the observed sample.

The collisional process excites the mutual orbital eccentricity of the binaries, acting against the effect of tides. Therefore only ∼10% of the objects reach total orbital circularization ($e \leq 10^{-4}$). In addition, our results predict that the population of contact binaries in the Trans Neptunian region should be small.

Ultra wide binaries are naturally obtained by the combined action of Kozai Cycles and Tidal Friction (KCTF) and collisional evolution, being the number and orbital distribution of them very similar to the ones of the observed population.

Published in: Monthly Notices of the Royal Astronomical Society, 455, 4487 (2016 February 1)

For preprints, contact abrunini@yahoo.com.ar

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On the Mass and Origin of Chariklo's Rings

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Observations in 2013 and 2014 of the Centaur 10199 Chariklo and its ring system consistently indicated that the radial width of the inner, more massive ring varies with longitude. That strongly suggests that this ring has a finite eccentricity despite the fast differential precession that Chariklo's large quadrupole moment should induce. If the inferred apse alignment is maintained by the ring's self-gravity, as it is for the Uranian rings, we estimate a ring mass of a few times 10^{16} g and a typical particle size of a few meters. These imply a short collisional spreading time of $\sim 10^5$ years, somewhat shorter than the typical Centaur dynamical lifetime of a few Myrs and much shorter than the age of the solar system. In light of this time constraint, we evaluate previously suggested ring formation pathways including collisional ejection and satellite disruption. We also investigate in detail a contrasting formation mechanism, the lofting of dust particles off Chariklo's surface into orbit via outflows of sublimating CO and/or N_2 triggered after Chariklo was scattered inward by giant planets. This latter scenario predicts that rings should be common among 100-km class Centaurs but rare among Kuiper belt objects and smaller Centaurs. It also predicts that Centaurs should show seasonal variations in cometary activity with activity maxima occurring shortly after equinox.

To appear in: The Astrophysical Journal

For preprints, contact `pan at astro dot utoronto dot ca`

or on the web at `http://arxiv.org/abs/1602.01769`

PAPERS RECENTLY SUBMITTED TO JOURNALS

Pluto's Atmosphere from the 29 June 2015 Ground-based Stellar Occultation at the Time of The New Horizons Flyby

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We present results from a multi-chord Pluto stellar occultation observed on 29 June 2015 from New Zealand and Australia. This occurred only two weeks before the NASA New Horizons flyby of the Pluto system and serves as a useful comparison between ground-based and space results. We find that Pluto's atmosphere is still expanding, with a significant pressure increase of 5±2% since 2013 and a factor of almost three since 1988. This trend rules out, as of today, an atmospheric collapse associated with Pluto's recession from the Sun. A central flash, a rare occurrence, was observed from several sites in New Zealand. The flash shape and amplitude are compatible with a spherical and transparent atmospheric layer of roughly 3 km in thickness whose base lies at about 4 km above Pluto's surface, and where an average thermal gradient of about 5 K km^{-1} prevails. We discuss the possibility that small departures between the observed and modeled flash are caused by local topographic features (mountains) along Pluto's limb that block the stellar light. Finally, using two possible temperature profiles, and extrapolating our pressure profile from our deepest accessible level down to the surface, we estimate a range of 12.4-13.2 μbar for the surface pressure.

Submitted to: Astrophysical Journal Letters
For preprints, contact `bruno.sicardy@obspm.fr`
or on the web at `http://arxiv.org/abs/1601.05672`

OTHER PAPERS OF INTEREST

Comet Formation in Collapsing Pebble Clouds. What Cometary Bulk Density Implies for the Cloud Mass and Dust-to-ice Ratio

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Comets are remnants of the icy planetesimals that formed beyond the ice line in the Solar Nebula. Growing from μm-sized dust and ice particles to km-sized objects is, however, difficult because of growth barriers and time scale constraints. The gravitational collapse of pebble clouds that formed through the streaming instability may provide a suitable mechanism for comet formation. We study the collisional compression of silica, ice, and silica/ice-mixed pebbles during gravitational collapse of pebble clouds. Using the initial volume-filling factor and the dust-to-ice ratio of the pebbles as free parameters, we constrain the dust-to-ice mass ratio of the formed comet and the resulting volume-filling factor of the pebbles, depending on the cloud mass. We use the representative particle approach, which is a Monte Carlo method, to follow cloud collapse and collisional evolution of an ensemble of ice, silica, and silica/ice-mixed pebbles. Therefore, we developed a collision model which takes the various collision properties of dust and ice into account. We study pebbles with a compact size of 1 cm and vary the initial volume-filling factors, ϕ_0, ranging from 0.001 to 0.4. We consider mixed pebbles as having dust-to-ice ratios between 0.5 and 10. We investigate four typical cloud masses, M, between 2.6×10^{14} g (very low) and 2.6×10^{23} g (high). Except for the very low-mass cloud ($M = 2.6 \times 10^{14}$ g), silica pebbles are always compressed during the collapse and attain volume-filling factors in the range from $\langle\phi\rangle_V \approx 0.22$ to 0.43, regardless of ϕ_0. Ice pebbles experience no significant compression in very low-mass clouds. They are compressed to values in the range $\langle\phi\rangle_V \approx 0.11$ to 0.17 in low- and intermediate-mass clouds ($M = 2.6 \times 10^{17} - 2.6 \times 10^{20}$ g); in high-mass clouds ($M = 2.6 \times 10^{23}$ g), ice pebbles end up with $\langle\phi\rangle_V \approx 0.23$. Mixed pebbles obtain filling factors in between the values for pure ice and pure silica. We find that the observed cometary density of $\sim$0.5 g cm^{-3} can only be explained by either intermediate- or high-mass clouds, regardless of ϕ_0, and also by either very low- or low-mass clouds for initially compact pebbles. In any case, the dust-to-ice ratio must be in the range of between $3 \lesssim \xi \lesssim 9$ to match the observed bulk properties of comet nuclei.

To appear in: Astronomy & Astrophysics

For preprints, contact `lorek@mps.mpg.de`

or on the web at `http://arxiv.org/abs/1601.05726`

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 papers submitted, in press, or recently published in refereed journals
⋆ Titles of conference presentations
⋆ 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.

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