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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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NEWS & ANNOUNCEMENTS

There was 1 new TNO discovery announced since the previous issue of *Distant EKOs*:

2012 BX85

and 4 new Centaur/SDO discoveries:

2000 GQ148, 2012 BR61, 2012 CE17, 2012 CG

Objects recently assigned numbers:

2010 EP65 = (312645)
2008 QD4 = (315898)
2010 EN65 = (316179)
2008 AP129 = (315530)

Objects recently assigned names:

1997 CS29 = Sila-Nunam

Current number of TNOs: 1249 (including Pluto)
Current number of Centaurs/SDOs: 337
Current number of Neptune Trojans: 8

Out of a total of 1594 objects:
644 have measurements from only one opposition
624 of those have had no measurements for more than a year
316 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 Dynamical Evolution of Dwarf Planet (136108) Haumea's Collisional Family: General Properties and Implications for the Trans-Neptunian Belt

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Recently, the first collisional family was identified in the trans-Neptunian belt (otherwise known as the Edgeworth-Kuiper belt), providing direct evidence of the importance of collisions between trans-Neptunian objects (TNOs). The family consists of the dwarf planet (136108) Haumea (formerly 2003 EL61), located at a semi-major axis, a, of ∼43 AU, and at least ten other ∼100 km-sized TNOs located in the region $a = 42$–44.5 AU. In this work, we model the long-term orbital evolution (4 Gyr) of an ensemble of fragments (particles) representing hypothetical post-collision distributions at the time of the family's birth based on our limited current understanding of the family's creation and of asteroidal collision physics. We consider three distinct scenarios, in which the kinetic energy of dispersed particles were varied such that their mean ejection velocities (veje) were of order 200 m/s, 300 m/s and 400 m/s, respectively. Each simulation considered resulted in collisional families that reproduced that currently observed, despite the variation in the initial conditions modeled. The results suggest that 60-75% of the fragments created in the collision will remain in the trans-Neptunian belt, even after 4 Gyr of dynamical evolution. The surviving particles were typically concentrated in wide regions of orbital element space centred on the initial impact location, with their orbits spread across a region spanning $\Delta a \sim 6 - 12$ AU, $\Delta e \sim 0.1 - 0.15$ and $\Delta i \sim 7 - 10°$, with the exact range covered being proportional to the v_{eje} used in the model. Most of the survivors populated the so-called Classical and Detached regions of the trans-Neptunian belt, whilst a minor fraction entered the Scattered Disk reservoir ($< 1\%$), or were captured in Neptunian mean motion resonances ($< 10\%$). In addition, except for those fragments located near strong resonances (such as the 5:3 and 7:4), the great majority displayed negligible long-term orbital variation. This implies that the orbital distribution of the intrinsic Haumean family can be used to constrain the orbital conditions and physical nature of the collision that created the family, billions of years ago. Indeed, our results suggest that the formation of the Haumean collisional family most likely occurred after the bulk of Neptune's migration was complete, or even some time after the migration had completely ceased, although future work is needed to confirm this result.

To appear in: Monthly Notices of the Royal Astronomical Society

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or on the web at `http://sites.google.com/site/patryksofialykawka/`

The Hubble Wide Field Camera 3 Test of Surfaces in the Outer Solar System: The Compositional Classes of the Kuiper Belt

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We present the first results of the Hubble Wide Field Camera 3 Test of Surfaces in the Outer Solar System (H/WTSOSS). The purpose of this survey was to measure the surface properties of a large number of Kuiper belt objects and attempt to infer compositional and dynamical correlations. We find that the Centaurs and the low-perihelion scattered disk and resonant objects exhibit virtually identical bifurcated optical colour distributions and make up two well defined groups of object. Both groups have highly correlated optical and NIR colours which are well described by a pair of two component mixture models that have different red components, but share a common neutral component. The small, $H_{606}\gtrsim 5.6$ high-perihelion excited objects are entirely consistent with being drawn from the two branches of the mixing model suggesting that the colour bifurcation of the Centaurs is apparent in all small excited objects. On the other hand, objects larger than $H_{606} \sim 5.6$ are not consistent with the mixing model, suggesting some evolutionary process avoided by the smaller objects. The existence of a bifurcation amongst all excited populations argues that the two separate classes of object existed in the primordial disk before the excited Kuiper belt was populated. The cold classical objects exhibit a different type of surface which has colours that are consistent with being drawn from the red branch of the mixing model, but with much higher albedos.

To appear in: The Astrophysical Journal
For preprints, contact `fraserw@gps.caltech.edu`
or on the web at `http://arxiv.org/abs/1202.0827`

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First Ultraviolet Reflectance Spectra of Pluto and Charon by the Hubble Space Telescope Cosmic Origins Spectrograph: Detection of Absorption Features and Evidence for Temporal Change

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We have observed the mid-UV spectra of both Pluto and its large satellite, Charon, at two rotational epochs using the Hubble Space Telescope (HST) Cosmic Origins Spectrograph (COS) in 2010. These are the first HST/COS measurements of Pluto and Charon. Here we describe the observations and our reduction of them, and present the albedo spectra, average mid-UV albedos, and albedo slopes we derive from these data. These data reveal evidence for a strong absorption feature in the mid-UV spectrum of Pluto; evidence for temporal change in Pluto's spectrum since the 1990s is reported, and indirect evidence for a near-UV spectral absorption on Charon is also reported.

Published in: The Astronomical Journal, 143, 22 (2012 January)

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“TNOs are Cool”: A Survey of the Transneptunian Region IV. Size/Albedo Characterization of 15 Scattered Disk and Detached Objects Observed with Herschel Space Observatory-PACS

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Physical characterization of Trans-Neptunian objects, a primitive population of the outer solar system, may provide constraints on their formation and evolution. The goal of this work is to characterize a set of 15 scattered disk (SDOs) and detached objects, in terms of their size, albedo, and thermal properties. Thermal flux measurements obtained with the *Herschel*-PACS instrument at 70, 100 and 160 μm, and whenever applicable, with *Spitzer*-MIPS at 24 and 70 μm, are modeled with radiometric techniques, in order to derive the objects' individual size, albedo and when possible beaming factor. Error bars are obtained from a Monte-Carlo approach. We look for correlations between these and other physical and orbital parameters. Diameters obtained for our sample range from 100 to 2400 km, and the geometric albedos (in V band) vary from 3.8% to 84.5%. The unweighted mean V geometric albedo for the whole sample is 11.2% (excluding Eris); 6.9% for the SDOs, and 17.0% for the detached objects (excluding Eris). We obtain new bulk densities for three binary systems: Ceto/Phorcys, Typhon/Echidna and Eris/Dysnomia. Apart from correlations clearly due to observational bias, we find significant correlations between albedo and diameter (more reflective objects being bigger), and between albedo, diameter and perihelion distance (brighter and bigger objects having larger perihelia). We discuss possible explanations for these correlations.

To appear in: Astronomy & Astrophysics

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or on the web at `http://arxiv.org/abs/1202.1481`

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TNOs are Cool: A Survey of the Trans-Neptunian Region V. Physical Characterization of 18 Plutinos Using Herschel PACS Observations

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The Herschel Open Time Key Programme *TNOs are Cool: A Survey of the Trans-Neptunian Region* aims to derive physical and thermal properties for a set of ∼140 Centaurs and Trans-Neptunian Objects (TNOs), including resonant, classical, detached and scattered disk objects. One goal of the project is to determine albedo and size distributions for specific classes and the overall population of TNOs.

We present Herschel PACS photometry of 18 Plutinos and determine sizes and albedos for these objects using thermal modeling. We analyze our results for correlations, draw conclusions on the Plutino size distribution, and compare to earlier results.

Flux densities are derived from PACS mini scan-maps using specialized data reduction and photometry methods. In order to improve the quality of our results, we combine our PACS data with existing Spitzer MIPS data where possible, and refine existing absolute magnitudes for the targets. The physical characterization of our sample is done using a thermal model. Uncertainties of the physical parameters are derived using customized Monte Carlo methods. The correlation analysis is performed using a bootstrap Spearman rank analysis.

We find the sizes of our Plutinos to range from 150 to 730 km and geometric albedos to vary between 0.04 and 0.28. The average albedo of the sample is 0.08 ± 0.03, which is comparable to the mean albedo of Centaurs, Jupiter Family comets and other Trans-Neptunian Objects. We were able to calibrate the Plutino size scale for the first time and find the cumulative Plutino size distribution to be best fit using a cumulative power law with $q = 2$ at sizes ranging from 120–400 km and $q = 3$ at larger sizes. We revise the bulk density of 1999 TC36 and find $\varrho = 0.64^{+0.15}_{-0.11}$ g cm^{-3}. On the basis of a modified Spearman rank analysis technique our Plutino sample appears to be biased with respect to object size but unbiased with respect to albedo. Furthermore, we find biases based on geometrical aspects and color in our sample. There is qualitative evidence that icy Plutinos have higher albedos than the average of the sample.

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SDSS Observations of Kuiper Belt Objects: Colors and Variability

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Colors of Trans-Neptunian Objects (TNOs) are used to study the evolutionary processes of bodies in the outskirts of the Solar System, and to test theories regarding their origin. Here I describe a search for serendipitous Sloan Digital Sky Survey (SDSS) observations of known TNOs and Centaurs. I present a catalog of SDSS photometry, colors and astrometry of 388 measurements of 42 outer Solar-System objects. I find a weak evidence, at the $\approx 2\sigma$ level (per trial), for a correlation between the $g-r$ color and inclination of scattered disk objects and hot classical KBOs. I find a correlation between the $g-r$ color and the angular momentum in the z direction of all the objects in this sample. These findings should be verified using larger samples of TNOs. Light curves as a function of phase angle are constructed for 13 objects. The steepness of the slopes of these light curves suggests that the coherent backscatter mechanism plays a major role in the reflectivity of outer Solar-System small objects at small phase angles. I find a weak evidence for an anti-correlation, significant at the 2σ confidence level (per trial), between the g-band phase angle slope parameter and the semi-major axis, as well as the aphelion distance, of these objects (i.e., they show a more prominent "opposition effect" at smaller distances from the Sun). However, this plausible correlation should be verified using larger sample. I discuss the origin of this possible correlation and argue that if this correlation is real it probably indicates that "Sedna"-like objects have a different origin than other classes of TNOs. Finally, I identify several objects with large variability amplitudes.

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Preprints available on the web at `http://arxiv.org/abs/1202.1538`

Coagulation Calculations of Icy Planet Formation at 15–150 AU: A Correlation Between the Maximum Radius and the Slope of the Size Distribution for Transneptunian Objects

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We investigate whether coagulation models of planet formation can explain the observed size distributions of transneptunian objects (TNOs). Analyzing published and new calculations, we demonstrate robust relations between the size of the largest object and the slope of the size distribution for sizes 0.1 km and larger. These relations yield clear, testable predictions for TNOs and other icy objects throughout the solar system. Applying our results to existing observations, we show that a broad range of initial disk masses, planetesimal sizes, and fragmentation parameters can explain the data. Adding dynamical constraints on the initial semimajor axis of 'hot' KBOs along with probable TNO formation times of 10–700 Myr restricts the viable models to those with a massive disk composed of relatively small (1–10 km) planetesimals.

To appear in: The Astronomical Journal

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or on the web at `http://arxiv.org/abs/1201.4395`

An Improved Model of the Edgeworth-Kuiper Debris Disk

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In contrast to all other debris disks, where the dust can be seen via an infrared excess over the stellar photosphere, the dust emission of the Edgeworth-Kuiper belt (EKB) eludes remote detection due to the strong foreground emission of the zodiacal cloud. In this paper, we access the expected EKB dust disk properties by modeling. We treat the debiased population of the known transneptunian objects (TNOs) as parent bodies and generate the dust with our collisional code. The resulting dust distributions are modified to take into account the influence of gravitational scattering and resonance trapping by planets on migrating dust grains as well as the effect of sublimation. A difficulty with the modeling is that the amount and distribution of dust are largely determined by sub-kilometer-sized bodies. These are directly unobservable, and their properties cannot be accessed by collisional modeling, because objects larger than $(10\ldots60)$ m in the present-day EKB are not in a collisional equilibrium. To place additional constraints, we use in-situ measurements of the New Horizons spacecraft within 20 AU. We show that, to sustain a dust disk consistent with these measurements, the TNO population *has* to have a break in the size distribution at $s \leq 70$ km. However, even this still leaves us with several models that all correctly reproduce a nearly constant dust impact rates in the region of giant planet orbits and do not violate the constraints from the non-detection of the EKB dust thermal emission by the COBE spacecraft. The modeled EKB dust disks, which conform to the observational constraints, can either be transport-dominated or intermediate between the transport-dominated and collision-dominated regime. The in-plane optical depth of such disks is $\tau_{\|}(r > 10~\mathrm{AU}) \sim 10^{-6}$ and their fractional luminosity is $f_d \sim 10^{-7}$. Planets and sublimation are found to have little effect on dust impact fluxes and dust thermal emission. The spectral energy distribution of an EKB analog, as would be seen from 10 pc distance, peaks at wavelengths of $(40\ldots50)$ μm at $F \approx 0.5$ mJy, which is less than 1% of the photospheric flux at those wavelengths. Therefore, EKB analogs cannot be detected with present-day instruments such as Herschel/PACS.

To appear in: Astronomy and Astrophysics

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or on the web at `http://arxiv.org/abs/1202.2257`

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`

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`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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