EPSC Abstracts
Vol. 13, EPSC-DPS2019-1271-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

A Potential New Surface Type in the Kuiper Belt

Megan E. Schwamb (1,2), Wesley C. Fraser (3), Michele T. Bannister (1), Michaël Marsset (4), Rosemary E. Pike (5), J. J. Kavelaars (3), Susan D. Benecchi (6), Matthew J. Lehner (5,7) Shiang-Yu Wang (5) Audrey Thirouin (8) Nuno Peixinho (9) Kathryn Volk (10) Mike Alexandersen (5) Ying-Tung Chen (5) Brett Gladman (11) Stephen D. J. Gwyn (3) and Jean-Marc Petit (12)

(1) Astrophysics Research Centre, Queen's University Belfast, UK, (2) Gemini Observatory, Hilo, HI, US, (3) Herzberg Astronomy and Astrophysics Research Centre, Victoria, British Columbia, Canada (4) Department of Earth, Atmospheric and Planetary Sciences, MIT, Cambridge, MA, USA, (5) Institute of Astronomy and Astrophysics, Academia Sinica, Taipei, Taiwan, (6) Planetary Science Institute, Tucson, AZ, USA, (7) Department of Physics and Astronomy, University of Pennsylvania, Philadelphia, PA USA, (8) Lowell Observatory, Flagstaff, AZ, USA, (9) Centre for Earth and Space Science Research of the University of Coimbra, Coimbra, Portugal, (10) Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA, (11) Department of Physics and Astronomy, University of British Columbia, Vancouver, BC, Canada, (12) Institut UTINAM UMR6213, CNRS, Univ. Bourgogne Franche-Comté, Besançon, France (mschwamb.astro@gmail.com)

Abstract

Colours of the Outer Solar System Origins Survey (Col-OSSOS) is probing Kuiper belt object (KBO) surface properties via near simultaneous g,r and J photometry from Gemini North with additional u-band imaging from CFHT. We will present the latest results from the survey including the surface properties of two outlier objects from the Col-OSSOS color distribution that may represent a new surface type present within the small KBO population.

Introduction

Excluding the Haumea collisional family, Kuiper belt object (KBO) surfaces are divided into two broad categories: spectrally featureless surfaces and the volatile rich dwarf planets. Unlike the Pluto-sized dwarf planets, most KBOs are either too small or hot to retain their primordial abundance of volatile ices [1]. Generally, the surfaces of these volatile- less bodies are poorly understood, with only water-ice being confidently identified on a few objects. Other than a linear spectral slope, the optical spectra of non- dwarf planet KBOs < 22 mag (< 200 km) are featureless. For the typically smaller > 22 mag KBOs, ground-based spectra are impossible; we must rely on what broadband photometric colors reveal. By studying these small bodies, we can probe the dynamical history and compositional structure of the early Solar System. The small KBO color-orbit distribution holds the key to determining the migration modes, distances, and timescales experienced by Neptune [2][3].

Colours of the Outer Solar System Origins Survey (Col-OSSOS) is probing KBO surface properties via near simultaneous near-infrared and optical photometry. Col-OSSOS is measuring colors for ~80 KBOs found in a brightness limited survey with a well-measured detection efficiency. This affords the first opportunity to explore the true frequency of KBO surface colors and types, subdivided by dynamical classification. In this talk we will present further studies of outlier objects found in our survey and what they tell us about the variety of surfaces present within the Kuiper belt.

1. Col-OSSOS

Started as a Gemini North Large and Long Program Col-OSSOS is measuring simultaneous g,r, and J photometry with Gemini and u-band photometry from CFHT for a sample of KBOs found in a brightness limited survey with a well-measured detection efficiency. Our unbiased statistics affords the first opportunity to explore the true frequency of KBO surface colors and types. Col-OSSOS is providing the first flux-limited compositional dynamical map of the outer Solar System.

Col-OSSOS taxonomic classifications of 30 KBOs compromise our first release sample (see Figure 1) [4]. Previous color measurements for KBOs in the same size region as the Col-OSSOS sample have errors of +/- 0.1 mag. By utilizing an 8-m telescope and carefully accounting for light curve variations as best as we can, we obtain with Col-OSSOS color measurement uncertainties of +/- 0.03 mag for nearly all objects in our sample. We clearly identify two compositional classes of dynamically excited KBO

population at a boundary of (g-r) = ~0.75: the neutral and red classes [4][5].

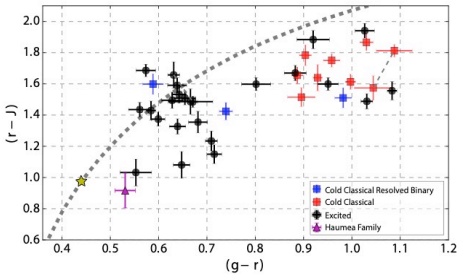

Figure 1: (r-J) versus (g-r) colors of KBOs observed by Col-OSSOS [4] The dynamically excited (black circles) split into two compositional classes, the neutral and red, in grJ color space. Solar colors are marked by the yellow star. The dashed curve indicates the reddening line, a line of constant spectral slope through the grJ spectral range, calculated using pysynphot software package [6]. Color measurements connected with a dashed line are objects with two epochs of color measurement.

2. A Potential New Surface Type

We have completed the photometry for an additional ~30 KBOs in our sample, and we have found evidence for a potential new surface type in the Kuiper belt. Col-OSSOS photometry finds at least two KBOs in our sample with surface colors unique compared to what has been previously measured for all small KBOs. The KBOs' colors indicate spectral features in the 0.6-0.7 micron region, which may reflect the broad absorptions seen on phyllosilicate-rich Solar System surfaces. In previous studies, other than water-ice, no material has been confidently identified in the spectra of small KBOs, including the silicate material which we know must make up some component of these bodies based on bulk density measurements. We will present observational evidence for this new surface type from a combined set of grizJ measurements from Gemini North with Col-OSSOS and other follow-up programs, and we will discuss the implications on the composition of the excited Kuiper belt.

Acknowledgements

The authors acknowledge the sacred nature of Maunakea, and appreciate the opportunity to observe from the mountain. This work is based on observations from the Large and Long Program and Fast Turnaround Program associated with Gemini Observatory and a Large Program on CFHT. We thank the Gemini North staff for their support of the Col-OSSOS program. In particular, we acknowledge the Gemini North and CFHT staff for their support of the Col-OSSOS program.

References

[1] Schaller, E. L., & Brown, M. E. 2007, ApJL, 659, L61

[2] Levison, et al. Origin of the structure of the Kuiper belt during a dynamical instability in the orbits of Uranus and Neptune, Icarus, 196, 258. 2008

[3] Nesvorny, D. Jumping Neptune Can Explain the Kuiper Belt Kernel, AJ, 150, 73, 2015

[4] Schwamb et al. Col-OSSOS: The Colours of the Outer Solar System Origins Survey, ApJS, in press

[5] R. E. Pike, et al. Col-OSSOS: Z Band Photometry Reveals Three Distinct TNO Surface Types, AJ, 154, 101, 2017

[6] Lim, P. L., Diaz, R. I., & Laidler, V, PySynphot, Users Guide (Baltimore, MD: STScI), 2015