

Type	Final Report
Grant	NAG 5-4669
Title	The Solar System Beyond Neptune
PI	David Jewitt Institute for Astronomy University of Hawaii 2680 Woodlawn Drive Honolulu, HI 96822
Period	04/01/97 - 12/31/01
Amount	\$272,495
Technical Officer	Joseph Boyce, David Nava(current)
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Summary of Completed Project

This proposal supported deep and wide-field optical imaging of the trans-Neptunian Solar System capitalising on our broad access to state-of-the-art facilities on Mauna Kea.

Key quantities determined include the size distribution of Kuiper Belt objects (a differential power law with an index -4), and the inclination and radial distance distributions. We identified an outer edge to the classical Kuiper Belt that has since been confirmed by independent workers. We also obtained an assessment of the population densities in the mean-motion resonances with Neptune and discovered the Scattered Kuiper Belt Object dynamical class. Scientific issues on which these measurements have direct bearing include the collisional environment of the Kuiper Belt, the origin of the short-period comets, and the origin by capture into resonance of Pluto and other Kuiper Belt objects.

Techniques Used

Measurements were taken using two large-format charge-couple device (CCD) mosaic cameras. The University of Hawaii 8k camera was employed at both the UH 2.2-m and Canada-France-Hawaii 3.6-m telescopes. A facility CCD camera was employed at the Keck 10-m telescope.

Surveys were conducted to assess the sky plane densities of Kuiper Belt Objects as a function of magnitude and ecliptic latitude. We employed a custom software package to analyse the data in near real-time and aggressively pursued follow-up astrometric observations to ensure that newly discovered KBOs were not lost.

Findings and Implications

Under this grant we have

- 1 Measured the optical to near infrared spectra of Kuiper Belt Objects (papers 1, 2 and 8). We found evidence for spectral diversity in the Kuiper Belt at both optical and infrared wavelengths, but no evidence for bimodality in the color distributions as has been reported by other workers.
- 2 Measured the surface density of Kuiper Belt Objects in the $20 \leq m \leq 26$ magnitude range and so determined the size distribution index within the Kuiper Belt (papers 3 and 4).
- 3 Wrote major invited reviews for Annual Reviews of Earth and Planetary Sciences (paper 5) and Protostars and Planets IV (paper 9).
- 4 Identified (paper 3) and assessed (paper 7) the population of the Scattered Kuiper Belt, a thick disk of objects external to the main belt an extending more than 1000 AU from the sun.
- 5 This grant supported a portion of the PhD research of University of Hawaii graduate student Chadwick Trujillo, who received his degree in the summer of 2000. Dr Trujillo is now a postdoc at Caltech. This grant also supported UH graduate student Scott Sheppard, who is now pursuing a PhD with the PI in a closely related area.

Major Publications

- 1 J. Luu and D. Jewitt (1998). "Optical and Infrared Reflectance Spectrum of Kuiper Belt Object 1996 TL66", Ap. J., 494, L117
- 2 D. Jewitt and J. Luu (1998). "Optical-Infrared Spectral Diversity in the Kuiper Belt". Astronomical Journal, 115, 1667-1670.

- 3 D. Jewitt, J. Luu and C. Trujillo (1998). "Large Kuiper Belt Objects: The Mauna Kea 8k CCD Survey". *Astronomical Journal*, 115, 2125-2135.
- 4 J. Luu and D. Jewitt (1998). "Deep Imaging of the Kuiper Belt with the Keck 10-m Telescope". *Ap. J. Lett.*, 502, L91-94.
- 5 D. Jewitt (1999). "Kuiper Belt Objects". *Annual Reviews of Earth and Planetary Sciences*, 27, 287-312.
- 6 D. Jewitt (1999). "The Kuiper Belt". *Physics World*, 12, 7, 37-41.
- 7 C. Trujillo, D. Jewitt and J. Luu (2000). . "Population of the Scattered Kuiper Belt". *Ap. J. Lett.*, 529, L103-106.
- 8 J. Luu, D. Jewitt and C. Trujillo (2000). "Water Ice in 2060 Chiron and Its Implications for Centaurs and Kuiper-Belt Objects. *Ap. J. Lett*, 531, L151.
- 9 D. Jewitt and J. Luu (2000). Physical Nature of the Kuiper Belt. In *Protostars and Planets IV*, edited by V. Mannings, A. Boss and S. Russell, University of Arizona Press, Tucson. pp:1201-1229.