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Limits on Rings and Debris Around 2014 MU69 Observed From *New Horizons*

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Abstract

NASA's *New Horizons* spacecraft flew past the cold classical Kuiper belt object 2014 MU69 on January 1, 2019. We used the spacecraft to perform a deep search for rings and orbital debris. We found no evidence for rings or debris to a level of I/F ~5×10^{-7} in approach, and 2×10^{-6} on departure.

1. Introduction

Based on the known existence of rings and/or orbital debris in the vicinity of other Kuiper belt objects, the *New Horizons* mission undertook an extensive search for dust in the region surrounding MU69. If millimeter-sized dust grains were present along the flyby path, they could threaten the safety of the spacecraft. Earth-based telescopes do not have the sensitivity or resolution necessary for a meaningful search in direct imaging, necessitating the use of the *New Horizons* spacecraft itself for the search.

2. Observations

New Horizons observed the MU69 system regularly on approach, starting roughly six weeks before the flyby. Observations continued until just after the encounter. Data were taken using *New Horizons'* Long-Range Reconnaissance Imager (LORRI), and the Multispectral Visible Imaging Camera (MVIC). Images taken on approach were typically at a phase angle ~11°. Sets of observations typically consisted of several hundred images, which were processed and reconstructed on the ground using several pipelines. The dense star field behind MU69 was typically removed based on images of the star field that had been observed by New Horizons at an earlier epoch. This stellar removal allowed substantially deeper sensitivity to any material in the system.

Outbound observations were taken at high resolution, within the first 24 hours after encounter. These observations were at a phase angle ~168°. Any dust would appear naturally brighter at high phase due to scattering properties, but the high phase also allows more solar stray light to enter the telescope.

After processing the images, we searched for rings both visually, and by summing pixels in radial annuli defined by an orbital plane. We assumed a variety of orbital planes for potential rings, including those oriented with respect to the Sun, to MU69's rotational geometry, and to the observer.

3. Ring Limits

We found no evidence for any rings around MU69. We will present our formal limits for a variety of assumed ring geometries and widths, in forward-scatter and back-scatter.

4. Figures

(continued)

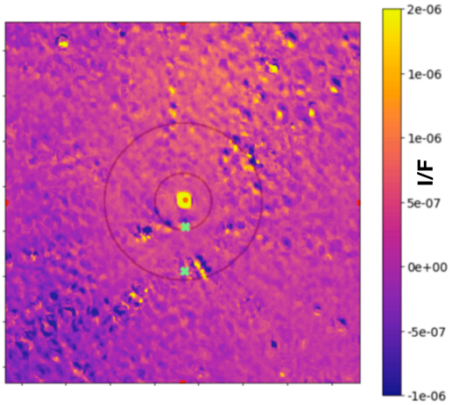

Figure 1. Typical reconstructed images stack of the MU69 system on approach, taken in the period up until two weeks before flyby. The small and large circles indicate distances of 3500 km and 10,000 km from MU69, respectively. All sources visible are artifacts of incompletely removed stars.

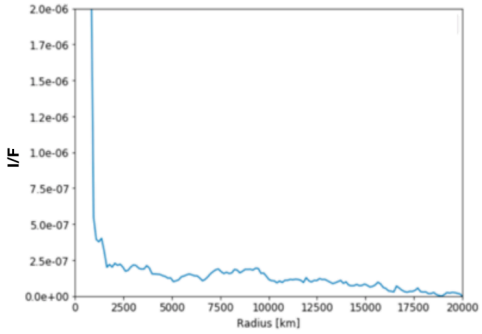

Figure 2. Radial profile of above reconstructed image, which assumes a ring geometry normal to the Sun. No rings are seen to an I/F limit of several 10^{-7}.

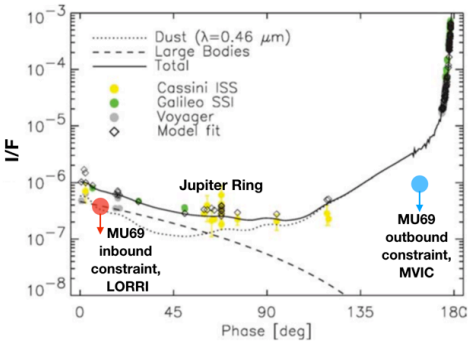

Figure 3. Comparison of overall inbound and outbound ring limits, for rings of 35 km width. The phase curve shown is of the Jupiter ring (from Throop et al 2004, Icarus 172). Our observations at MU69 would easily have discovered a ring of the same I/F as the Jovian main ring, but much narrower and illuminated by far weaker solar flux.

5. Acknowledgements

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