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Inactive Comets from the Oort Cloud: Manxes are Tracing the History of Solar System Formation

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Abstract

Manx comets are nearly tailless objects on long-period comet (LPC) orbits, in strong contrast to the appearance of normal LPCs. They may early inner solar system remnants, ejected to the Oort cloud at the time of planet formation. The fraction of rocky objects on these orbits sets strong constraints on the dynamical models attempting to reproduce our current solar system. We present our program to observe Manx comets and the implications on the early solar system.

1. Introduction

Recent dynamical models succeed in reproducing key characteristics of our current solar system [1]; some of these models require significant migration of the giant planets, while others do not. These models provide very different predictions on the presence of rocky inner solar system material expelled from the inner Solar System into the Oort cloud.

Determining the amount of S-type material present in the Oort cloud could therefore be the key to verifying the predictions of the planet migration-based dynamical models.

The Pan-STARRS1 telescope is now the most prolific facility discovering inactive and very low activity comets on long-period comet orbits, the Manx comets. As they are now numerous enough for a population study, and thanks to the availability of large telescopes allowing us to characterize them, we embarked on a program to study the surface of Manx comets, in order to identify the rocky ones and to estimate their fraction.

2. Observations

A detailed statistical analysis indicated that measurements of a sample of 50 Manx comets will allow us to rule out some of the dynamical models representing the early solar system, depending on the number of S-type Manx objects present in the sample. The size of the sample is a good trade-off between the amount of observation time required and the constraints on our current (lack of) knowledge on the early times of the solar system.

We secured time on the ESO Very Large Telescope (VLT) and Gemini North (GN) to acquire visible and near-IR photometric observations.

Our current list of Manx candidates includes 87 objects. While 31 of these were lost or became too faint before we could schedule observations, we already secured spectrophotometric observations on 22 objects, and 5 more are queued on GN and 6 on the VLT.

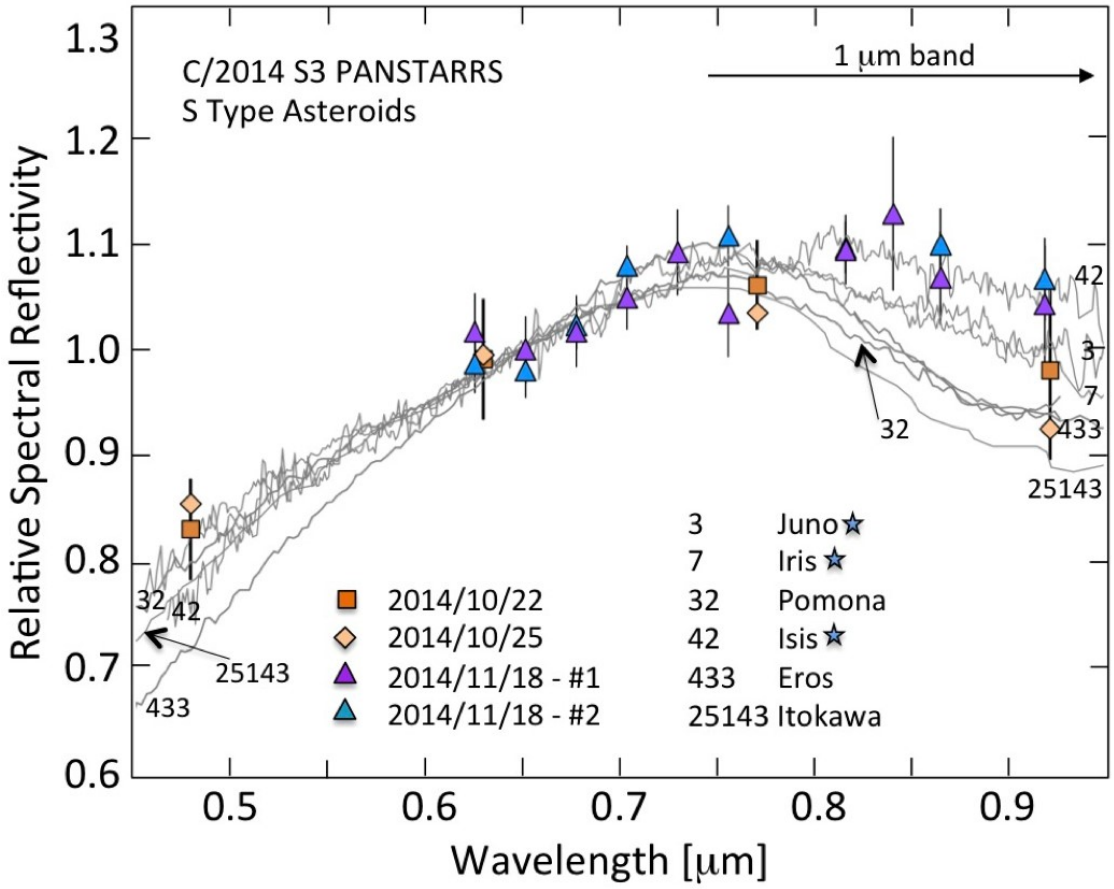
One of these Manx objects, C/2014 S3 (PANSTARRS), has a surface that is physically similar to an inner main belt rocky S-type asteroid (see Fig.1 for a spectrum and [1] for details). Modern inner solar system S-type asteroids are rocky and do not possess volatiles [2]. However C/2014 S3 displays a very faint, weak level of comet-like activity. The activity implies that C/2014 S3 has retained a tiny fraction of the water that is expected to be present at its formation distance in the inner solar system [3]. We may be looking at fresh inner solar system Earth-forming material that was ejected

from the inner solar system and preserved for billions of years in the Oort cloud.

Our survey of Manx comets is now about half-way to the required sample of 50 objects. At this stage, one S-type object was identified, and the others present a wide variety of colours, from neutral to very red, a much greater diversity of surfaces than that of comet surfaces.

This presentation will report on the current status of our survey and possibly propose some first conclusions on the consequences on the early solar system

Fig.1: Reflectivity spectrum for Manx comet C/2014 S3, from the CFHT in Oct.2014 andVLT in Nov.2014, and spectra of six S-type asteroids. All spectra are normalized to 1 at 0.65 mm



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