Neptune's journey during early planet formation was 'smooth and calm'

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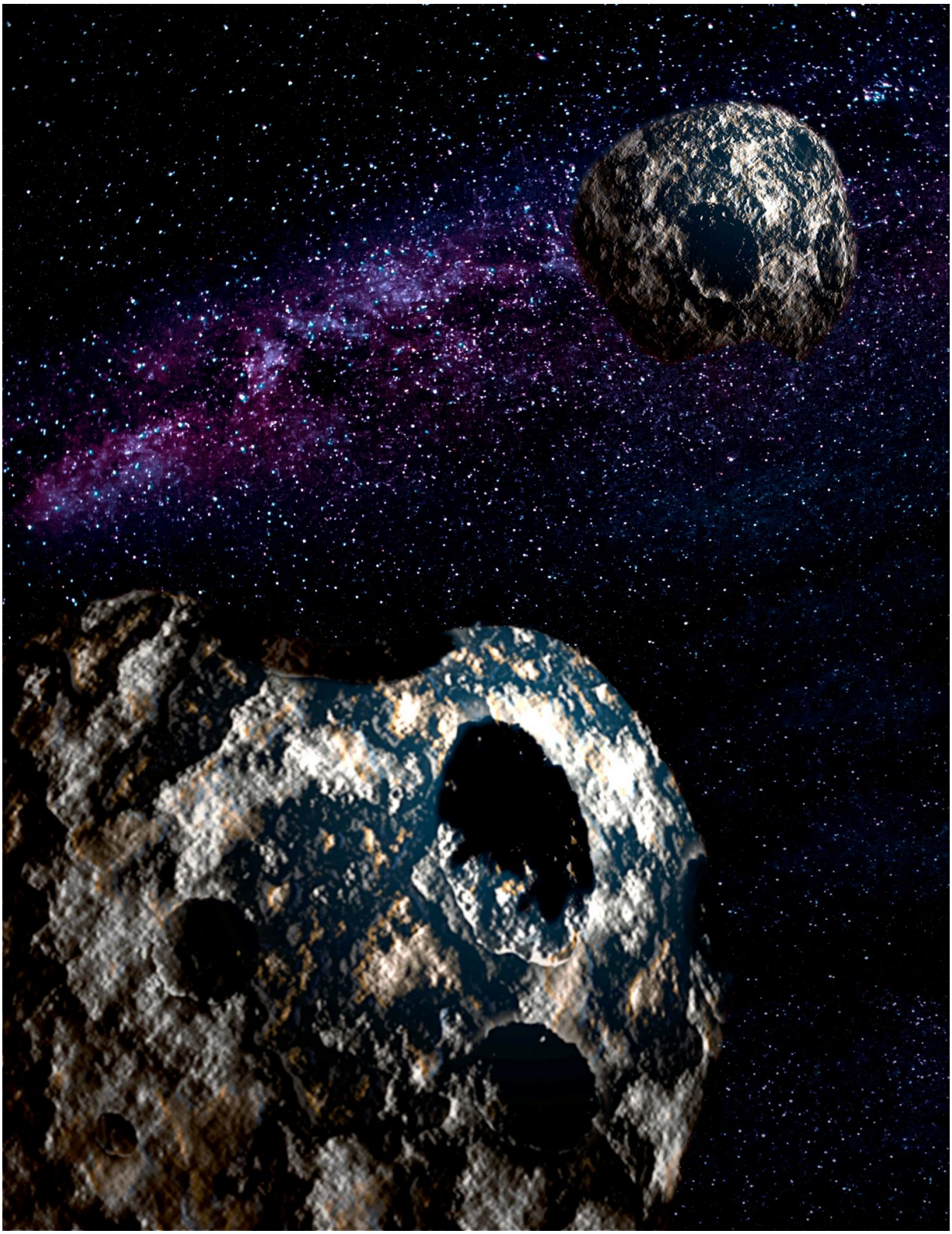

Artist's conception of a loosely tethered binary planetoid pair like those studied

by Fraser et al. in this work which led to the conclusion that Neptune's shepherding of them to the Kuiper Belt as gradual and gentle in nature. Credit: Gemini Observatory/AURA, artwork by Joy Pollard

Dr Wes Fraser from Queen's led an international research project 'Colours of the Outer Solar Systems Origins Survey' Col-OSSOS, which uses data collected from the Frederick C. Gillett Gemini North Telescope and Canada-France-Hawaii Telescope (CFHT) both on Maunakea in Hawaii. By simultaneously using two world class telescopes, Dr Fraser's team was able to produce unique research with a global impact.

The study focused on the Kuiper Belt - a region of space beyond the gas giant Neptune. The area holds more than 1,700 known icy objects, which are remnants of the early Solar System. Normally objects that are formed in this area are red in colour.

However, during his research Dr Fraser identified a small number of 'oddball' objects, which stand out as uniquely blue and are zipping around in binary pairs that orbit around each other, like the moon orbits the earth.

Astronomers have always thought that these objects formed in the heart of the Kuiper Belt but Dr Fraser's findings, which have been published in *Nature Astronomy* today (Tuesday 4 April), suggest that the blue binaries actually formed in a region much closer to the Sun and were then shepherded by Neptune's gravitational nudges onto their current orbits in the distant Kuiper Belt several billions of years ago.

Dr Fraser's research indicates that when Neptune moved from 20 AU to its current location at 30 AU, this was a very slow and calm movement,

which allowed the fragile and loosely bound binaries to be pushed out a similar distance to where they are found currently without being disrupted into two separate single objects.

Discussing the significance of the findings, Dr Fraser said: "This research has opened the window to new aspects of understanding the early stages of planet growth. We now have a solid handle on how and where these blue binaries originated.

The Gemini North telescope (foreground, right) with the Canada-France-Hawaii Telescope in background (left). Image obtained during observations for Col-OSSOS and both telescopes are pointing at the same target. Credit: The Gemini North telescope (foreground, right) with the Canada-France-Hawaii Telescope in background (left). Image obtained during observations for Col-OSSOS and both telescopes are pointing at the same target. Credit: Gemini Observatory/AURA, photo by Joy Pollard.

"There has been some evidence around how Neptune moved outwards to 30 AU. Our hypothesis about how these blue binaries came to be where they are requires that Neptune's migration was largely a smooth and calm movement.

"This novel programme uses two world-class telescopes: the Gemini-North and Canada-France-Hawaii telescopes, simultaneously. In doing so, we are able to gather comprehensive spectral information spanning the ultra-violet, optical, and near-infrared wavelength ranges. Without this programme and the partners involved, this major research breakthrough would not have been possible."

Meg Schwamb, astronomer at the Gemini Observatory, commented: "Working closely together, Gemini North and the Canada-France-Hawaii telescopes coordinated their movements to observe the Col-OSSOS Kuiper belt objects at nearly the same time."

"These simultaneous observations on Maunakea allowed us to measure the light from the same side of the Kuiper Belt object, removing one of the main challenges in studying Solar System bodies that rotate."

Todd Burdullis, QSO operations specialist at CFHT who helped to co-ordinate the observations, commented: "Facilitating the simultaneous observations with the Col-OSSOS team and Gemini Observatory was challenging, but paved the way for a greater understanding of the origins of these blue binaries.

"In tandem, the two facilities observed all the colours of the outer solar system for the Col-OSSOS team."

Provided by Queen's University Belfast