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Densities and interior structures of icy dwarf planets

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The icy dwarf planets of the outer solar system are a class of objects with similar masses to the mid-sized icy satellites, but extremely different formation and environmental histories. Owing to their extreme distances from the earth, only limited information is available about the physical properties of these bodies, but the unusual prevalence of satellites to icy dwarfs allows us to measure accurate masses for many of the largest objects. These measurements, combined with radiometric measurements of the object size using Spitzer Space Telescope measurements or direct Hubble Space Telescope measurements allows us to determine ice dwarf densities with modest accuracies. To first order, all of the measured icy dwarfs have densities similar to the ˜2 g/cc densities of Pluto, in striking contrast to smaller Kuiper belt objects which have been thought to have densities of 1 g/cc and smaller. These densities are consistent with expected ice-rock fractions for bodies formed in the proto-solar nebula.

One object, 2003 EL61, has a significantly higher density of 2.6 g/cc, if its density can be inferred from assuming that it takes a fluid equilibrium shape based on its rotation rate. 2003 EL61 has recently been shown to be the parent body of a collisional family in the Kuiper belt, so the high density could plausible indicate that 2003 EL61 was differentiated prior to its collision and that the collision removed the outer icy mantle and left, predominantly, the inner rocky core. Recent work, however, has suggested that bodies such as 2003 EL61 may retain sufficient shear strength to have a shape different from that expected from fluid equilibrium. Observations obtained with the Hubble and Spitzer Space Telescopes will be used to directly constrain the size and shape of 2003 EL61 and measure the true density independent of fluid assumptions.