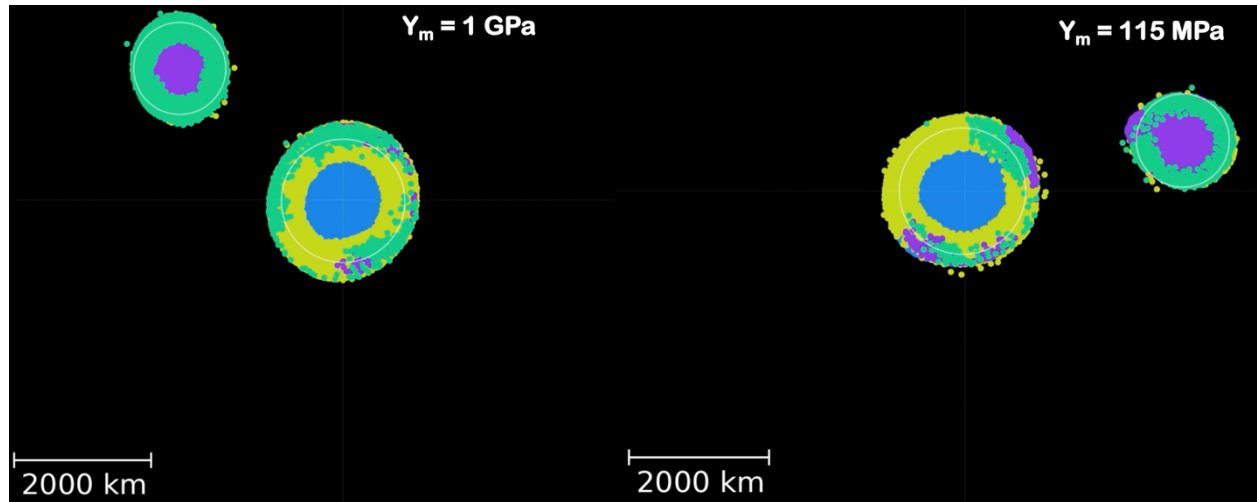

Capture of an ancient Charon around Pluto

In the format provided by the
authors and unedited

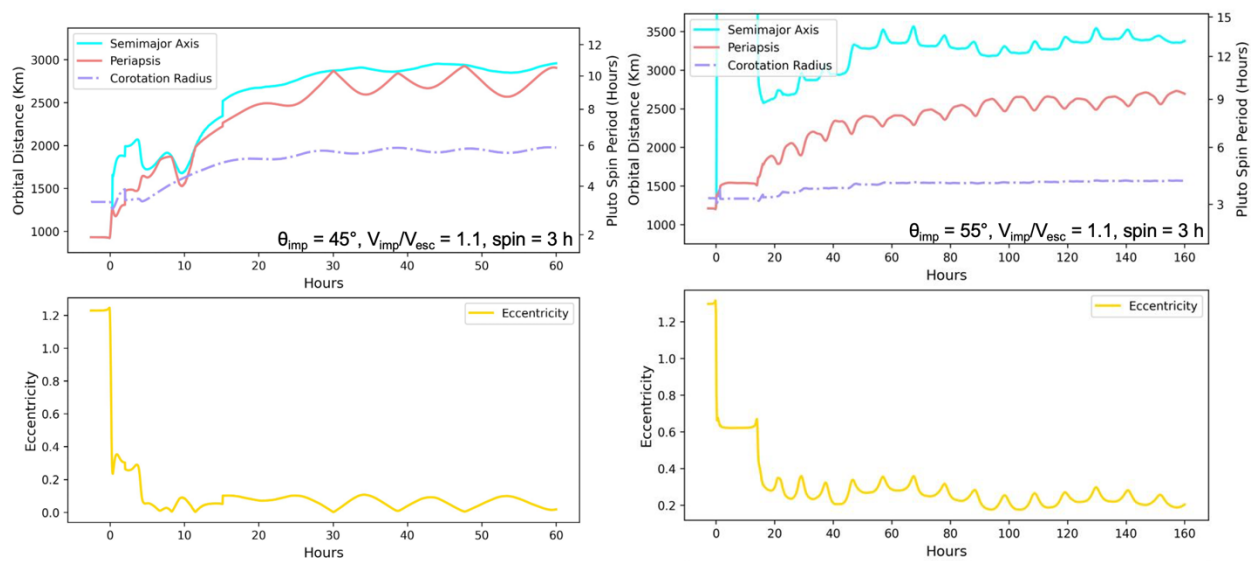
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Supplementary Figure 1. Contrast between a strong Y_m for ice used in the Pluto-Charon-like collision shown in Figs. ~1 and 2 ($\theta_{\text{coll}} = 45^\circ$, $v_{\text{coll}}/v_{\text{esc}} \sim 1.1$, 3 h prograde rotation, shown in Fig. 2), left, and the same collision parameters with a weaker Y_m , right, performed with 100,000 particles.



Supplementary Figure 2. The evolution of semimajor axis, periapsis, and eccentricity for the nominal case (left, $\theta_{\text{coll}} = 45^\circ$, $v_{\text{coll}}/v_{\text{esc}} \sim 1.1$, 3 h prograde rotation, shown in Fig. 2), and for a somewhat more oblique impact angle (right, $\theta_{\text{coll}} = 55^\circ$), otherwise the same. The latter is also kiss-and-capture, but the captured orbit is more eccentric, leading to some post-detachment collisions where periapsis intersects the combined radii, but is outside of corotation so also evolves out to a stable orbit.



Supplementary. Table 3. ANEOS for water ice. Presented as used in SPHLATCH.

```

*****
*****
ANEOS1 -6 'ice' THUG=-1 RHUG=-1 LONG
*      nel  neos  rhoref   tref   pref   Bref   Grun.
Tdebye
ANEOS2  2    4    1.11    0.02008    0   -1.7e5    0.58    -
0.045
*      Tg    3C24    Es      Tmelt    C53    C54    H0
C41
ANEOS3    .9    2      3.34e10    0.0224    0      0    0
0
*      rhomin D1    D2    D3    D4    D5    Hf    -rholiq
ANEOS4  0.0    0.0    0.0    0.0    0.0    0.0  4.85e9  -1.
*      Up    Lo    alpha beta  gamma C60    C61    C62
ANEOS5  0.0    0.0    0.0    0.0    0.0    0.8    0.    0.26
*      Ionization model Reactive chemistry Molecular Clusters
Pc
*      Flag      Eshift    Sshift    Rbond  Ebind  IntDOF
flag  exp
ANEOS6  1      0.      0.      0.E-8    3.2    0.
1.    1.8
*      Zi      fi
ANEOS7  1      2./3.
ANEOS8  8      1./3.
***** END of input for ANEOS *****

```