Dynamics and Rotation

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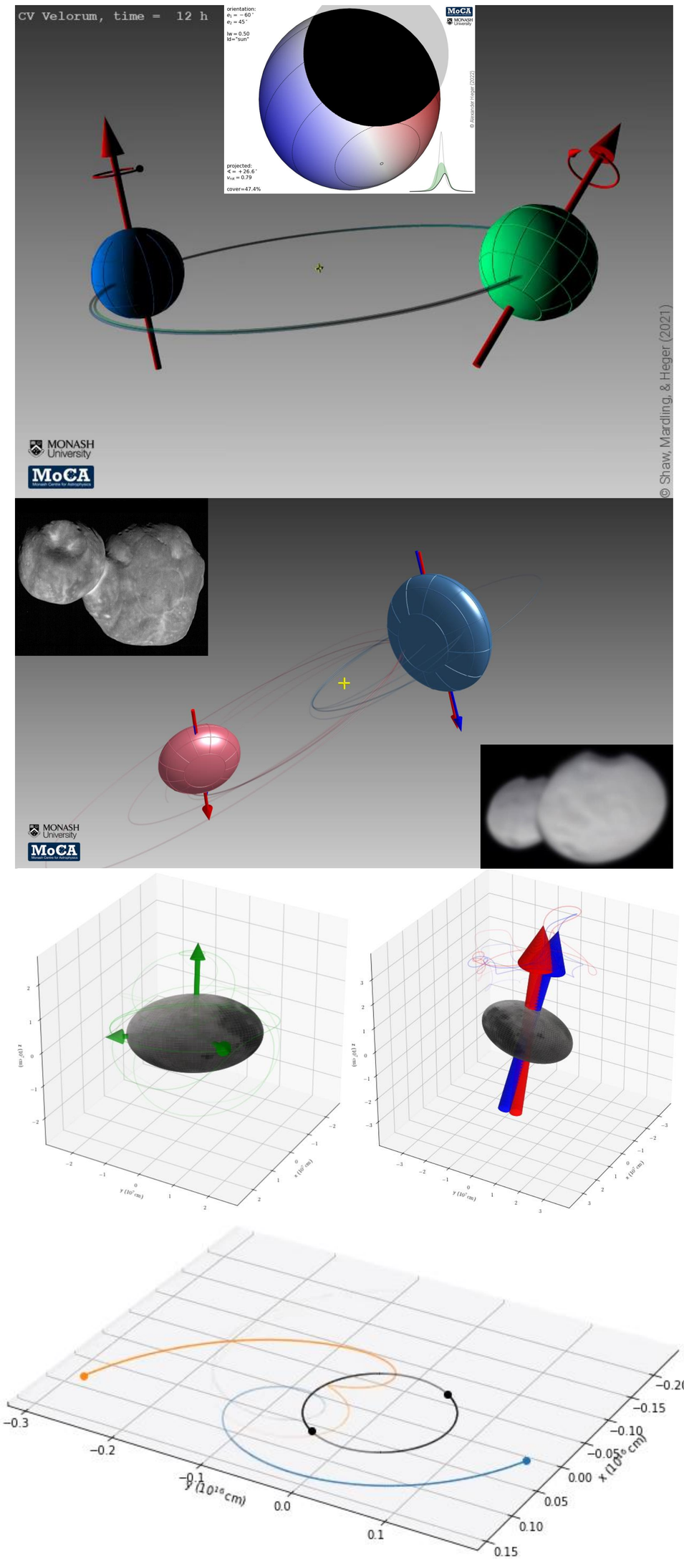

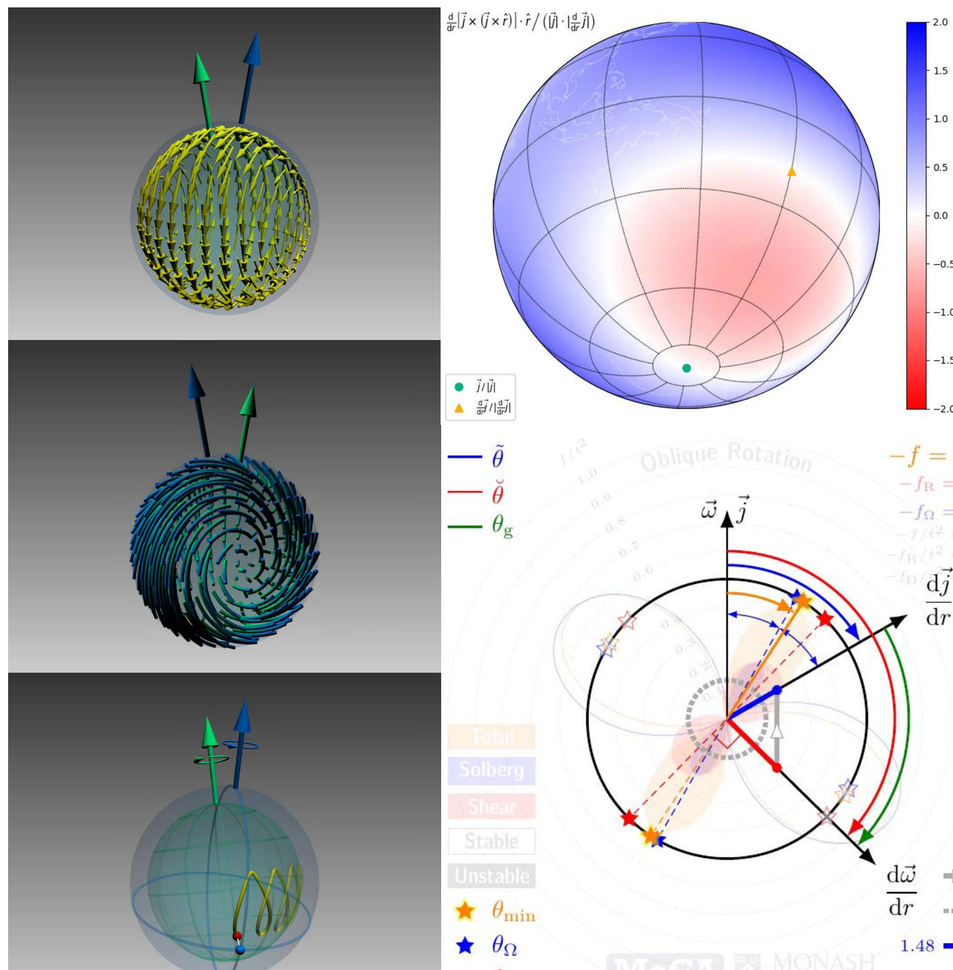

Evolution of oblique multiple stars
Most stars are born in binaries. They naturally spin.
But how does their spin magnitude and *direction* evolve due to tidal interactions and evolution of the stars?

Main: CV Velorum binary star system.
Orbit and star relative sizes are to scale.

Insert: Covering up one star in an eclipse affects spectral line shape and location, allowing to determine stellar rotation and obliquity.

Other projects include evolution of planetary systems and moons.

Evolution of small bodies in the solar system:
Asteroid collisions due to quadrupole interactions
Arrokoth, an asteroid in the Kuiper belt, visited by New Horizons space probe, is assembled from two components, Wenu and Weeyo (*Top left insert*). We can now explain how these objects came together due to Kozai-Lidov oscillations and quadrupole interactions (*Main panel*). With that, numerical simulations of the collision (*Bottom right insert*) remarkably well reproduce the observed shape.

Evolution of small moons with permanent quadrupole moment:
Tumbling of the Saturn moon Hyperion
Triaxially-deformed small moons can experience chaotic *"tumbling"*.

Left: Track of principal axes (*green arrows and lines*).

Right: Angular momentum (*blue*) and angular velocity (*red*). In the general case of deformed bodies, the two are not parallel.

Tidal disruption of single and multiple stars by black holes
Tidal disruption of a binary stars (*blue* and *orange* objects) by a supermassive binary black hole (***black***) of one millions solar masses each.

Evolution of misaligned rotation in the stellar interior
Due to accretion form different directions during formation, or due to tidal interaction with companion stars, the layers inside a star may rotate in different directions.

Left: Green and *blue* arrows indicate the angular velocity vector of the inner and outer shells. *Top:* shear field (*yellow* arrows). *Middle:* stretched magnetic field lines (*blue*–*green*). *Bottom*: Track (*yellow*) of a point relative to the layer above .

Top Right: Domains of dynamical instability due to differential rotation.

Bottom Right: Analysis of stability due to radial angular velocity (ω) and angular momentum (j) gradients.