Tilting at Europa

With recent geologic activity and warm saltwater over a rock-rich centre, Jupiter's moon Europa is on the short list of places in the Solar System that could host present-day microbial life, so understanding its geology is a top priority for the planetary science community. And yet we know frustratingly little about it.

Ever since the twin Voyager spacecraft first revealed Europa's surprising surface, geophysicists have been trying to decode the messages hidden in its criss-crossing ridges and furrows. The source of energy for Europa's active geology probably originates in a peculiarity of the moon's orbit around Jupiter. Like most moons, Europa is locked in spin-orbit resonance, so that it rotates once for each orbit around Jupiter, keeping the same side facing Jupiter all the time. But thanks to gravitational pushes and pulls from Jupiter's other big moons, Europa's orbit is slightly eccentric. That means that Europa nods its face east and west slightly as it completes each orbit.

This non-circularity creates periodic stresses in Europa's crust, and models for these periodic stresses have successfully explained some larger types of Europan cracks. But for the smallest, kilometre-scale fissures, it has been difficult to explain what seems to be a random pattern of crack orientations, cutting across each other haphazardly. Past work has implicated a phenomenon called non-synchronous rotation, where tidal forces cause the entire rigid icy spherical shell of Europa's outermost crust to rotate independently of the rocky core, lubricated by the liquid ocean between them. But this phenomenon must operate very slowly, since non-synchronous rotation was not observed in the 11 years separating images taken by the Voyager and Galileo spacecraft of the same locations.

However, in a new study published last month (*Icarus* **226,** 841–859; 2013), Alyssa Rhoden and Terry Hurford found an error in previous work that favours non-synchronous rotation. They mapped the orientations and order of cracks in Galileo's highest-resolution observation of cracked terrain, and compared them to their corrected theoretical models. They found that a slightly tilted rotation axis (about 1 degree of tilt) provided a better fit to the observed crack orientations than non-synchronous rotation. Under the influence of Jupiter's gravity, a tilted spin axis would change orientation rapidly over time, shifting local stresses and allowing cracks to open at all different compass orientations. So maybe Europa's spin axis was once tilted.

In fact, Europa's spin axis could be tilted now. We don't actually know whether it is or is not. Voyager and Galileo observations were not detailed enough to see the kilometre-scale cracks in most locations, so Rhoden and Hurford's mapping work cannot be extended to other regions of Europa to improve the statistics. We lack the data needed to answer many of our most basic questions about Europa. ❐

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The journalist's take

NASA's Jet Propulsion Laboratory issued a press release about this paper on 18 September, but as far as I can tell, not a single print article or even blog entry was composed about it. I conducted a casual survey of a handful of space journalists to ask why. Although several said they had considered covering the study, for one reason or another it 'didn't make the cut.'

Several factors are likely to have contributed. One is that the paper was mostly theoretical. Europa is a playground for physicists: a smooth, rigid, spherical shell overlies an effectively frictionless water layer, and hundreds of years of observations have constrained most of its orbital characteristics (except those of interest in this study — axial tilt and non-synchronous rotation). But beautiful mathematical models are difficult to translate into prose that is accessible to the public.

Another factor that prevented attention is that its conclusions can't be expressed in the form of an extreme. It is an incremental result that performs an important function of pointing out a technical error in previous work and suggests a new way forward in scientists' communal effort to explain Europa's oddities. This is the way good science proceeds — but it doesn't make for punchy headlines.

Finally, the beautiful images used in this study are nearly 15 years old, and already familiar. Galileo obtained a grand total of 700 tiny images of Europa, with only a few of them at high spatial resolution. Europa scientists are resourceful, continuously finding ways to wring new results out of old data; but the recurrence of familiar pictures makes the science seem stale, even when it's fresh. Ironically, a lack of new data from Europa, and this perception of staleness, may be eroding public support for sending a new mission there to gather new data.

To combat waning interest, Rhoden and four other scientists have launched the 'Destination: Europa' campaign (http://europa.seti.org/), which aims to inform and excite planetary scientists and the public about Europa and potential missions. A 'Destination: Europa' special session at the upcoming American Geophysical Union meeting (9–13 December) is an effort to remind the scientific community of how fascinating Europa is, and how many questions about it we have yet to answer.