elegans) could be used to explore this more; its genome is fully known[13]. Each and every adult roundworm has precisely the same number of cells (apart from sex cells), and the history of every one of these cells is known, providing a basis for an assembly-theory analysis. It would seem ideal for taking the project further.

George F. R. Ellis is in the Mathematics Department of the University of Cape Town, Rondebosch 7700, Cape Town, South Africa.
e-mail: george.ellis@uct.ac.za

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Astronomy

Violent collision rocks a young planetary system

Carl Melis

When two worlds collide, they leave more than the shambles of dusty ejecta. Astronomers have detected light from a post-collision remnant, providing the best evidence so far for planetary-scale collisions in exoplanetary systems. **See p.251**

Fledgling planetary systems are thought to undergo huge collisions[1], but evidence for these events outside the Solar System has been far from concrete[2]. One signal for such violence is a brightening of emission at infrared wavelengths from the 'synestia' – the post-collision remnant[3]. On page 251, Kenworthy *et al.*[4] report such a brightening associated with a young Sun-like star caught in the aftermath of a large-scale collisional event between two planets in its outer planetary system. The observation is unprecedented, and brings fresh insight into the early evolution of planetary systems and worlds like our own.

Humankind has enjoyed a period of planetary-system stability in which Earth's surface has generally been left unperturbed. This hasn't always been the case – for an example of a life-squelching event, think what happened to the dinosaurs. Indeed, Earth's first billion years were marked by episodes of collisional activity that ranged from catastrophic (such as the event that formed the Moon) to possibly necessary for the eventual formation of life (such as the delivery of water and organic molecules by comets or asteroids). Episodes of enhanced collisional activity early in the Solar System's history were driven by instabilities, especially those involving the wanderings of Jupiter and Saturn[5,6].

The collision observed by Kenworthy and colleagues occurred in another planetary system, and was initially recognized when its star dimmed suddenly in 2021. The authors' subsequent investigation of the system's infrared and optical emissions revealed that the dimming was linked to an eclipse lasting around 500 days, which overlapped with an infrared brightening that began 2.5 years before the eclipse (Fig. 1). Their modelling suggests that these two events resulted from a collision between two exoplanets with a combined mass several times that of Earth, producing dust that serendipitously blocked our view of the host star.

Although both the observations and modelling provide a compelling case for the detection of a planetary-scale collisional event, they leave open questions about the general properties of the two colliding planets and the star around which the event occurred. That the star is Sun-like is implicit in the shape of its spectrum and its brightness, given its distance from Earth. And Kenworthy *et al.* estimate that the star is around 300 million years old on the basis of its rotational period, which they derived from variations in the light emitted before the collision. Such characterization is on the sparse side for exoplanetary science, which typically adheres to the principle 'know thy star, know thy planet' (see go.nature.com/3k58wkw).

The properties of Kenworthy and colleagues' star and planets are therefore known only within certain ranges. The pre-impact masses of the two planets could have ranged from roughly an Earth mass up to something closer to that of Neptune. The temperature of the synestia suggests it is unlikely that both bodies were pure rock, and instead indicates that they also contained some water or other compounds that were not dominated by hydrogen or helium. The synestia must be separated from its host star by a distance ranging from twice to 16 times the Earth–Sun distance. Any

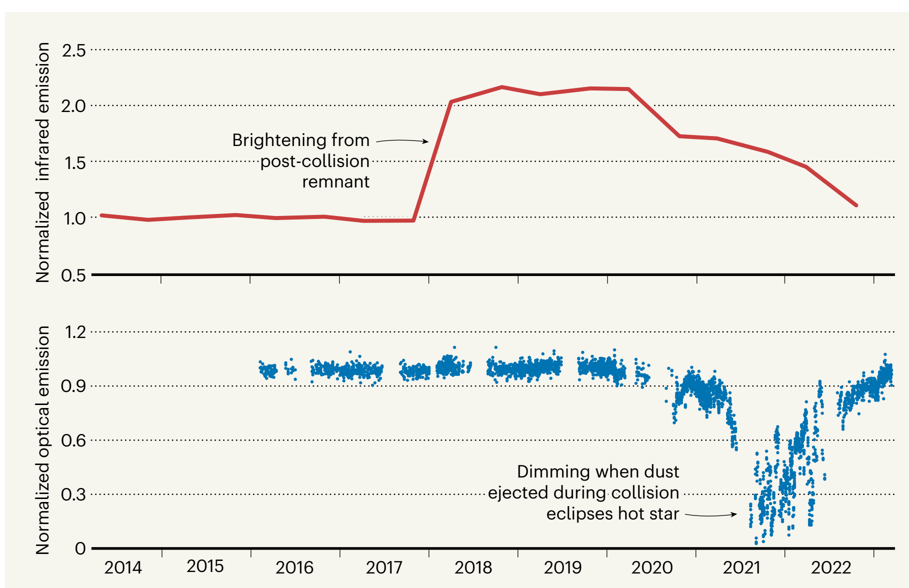

Figure 1 | Signs of a planetary collision. Kenworthy *et al.*[4] detected a brightening of infrared emission from the star ASASSN-21qj, indicative of hot material produced by the collision of two planets. The brightening lasted for around 1,000 days, and overlapped with a dimming of optical-wavelength light from the same system. The dimming event came 2.5 years after the brightening began, when debris from the collision eclipsed the host star. It lasted 500 days and was first reported in 2021. (Adapted from Fig. 1 in ref. 4.)

closer, and the remnant would have been too small to emit the amount of infrared light observed. Any farther, and the dusty ejecta would have been moving much more slowly than the velocity measured as it crossed the face of the host star.

The age of Kenworthy and co-workers' system is paramount in assessing its relevance to planet formation and evolution. If the system were around 100 million years old, it would be comfortably within the realm of the final stages of rocky-planet assembly. However, the authors' estimates put its age at 300 million years, conflicting with such an interpretation and placing it in the ranks of other older Sun-like stars that have undergone major collisional events[7,8].

Assuming that a stellar age of 300 million years is correct (future characterization efforts to confirm this figure are certainly warranted), it is likely that Kenworthy and co-workers' discovery has more to do with planetary evolution than formation. Specifically, this planetary system could be undergoing a reorganization similar to an event in our Solar System's evolution, known as the late heavy bombardment phase, in which the inner planetary system was subjected to a spate of asteroid impacts. Unlike in that phase, however, the star observed by the authors is experiencing true chaos: the collision of mature planets in its outer planetary system.

Further studies of this collision event should focus on the ejecta, as well as the overall architecture of the planetary system. The former goal would benefit from observations with the James Webb Space Telescope, which would easily detect leftover ejecta dust. However, such attempts could come up empty-handed if the ejecta has already dissipated. In that case, measuring the timescale on which it disappeared would be valuable for developing models of planetary collisions and their evolution. And although it is probably too difficult to detect the gravitational tug of the synestia on the star, a technique called Doppler monitoring could be used to constrain what is (or, more probably, isn't) orbiting between the remnant and the stellar host – information that will be crucial for ascertaining what led to the collision event.

"Further studies of this collision event should focus on the ejecta, as well as the overall architecture of the planetary system."

The key insight missing from the current understanding of these drastic planetary-system shake-ups is the frequency with which they occur, but determining it precisely presents a real challenge. Combining simulation results[9] with Kenworthy and co-workers' findings, it seems plausible that collisions between mature planets are much more common than was previously thought. Large-scale violent planetary collisions could well be the norm, and have probably had a role in shaping planetary systems throughout the Universe.

Carl Melis is in the Center for Astrophysics and Space Sciences, University of California, San Diego, La Jolla, California 92093, USA.
e-mail: cmelis@ucsd.edu

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