is the same as Double Chooz and Daya Bay, but it has two 16-ton detectors and six reactors. RENO has upped the ante with results from a longer exposure that has better statistics: this collaboration finds that $\sin^2(2\theta_{13}) = 0.113 \pm 0.013(\text{stat.}) \pm 0.019(\text{syst.})$, which indicates non-zero θ_{13} at more than 6σ. Given the combination of all these different experiments that use different approaches, it certainly looks as though the third angle has finally been measured, opening a new chapter in neutrino physics.

So where do we go from here? First, it is important for T2K in Japan to obtain statistically compelling data now that it is running again post-earthquake, to prove once and for all that the same effect is seen in both types of experiment (that is, for accelerator-generated neutrino beams as well as reactor-generated neutrino fluxes). As the reactor experiments take more data and refine their analyses, the comparison of their results should provide an accurate and convincing determination of θ_{13}.

The most interesting thing, however, will be to compare these reactor values with those that will be determined by T2K and by the NOνA long-baseline experiment that is under construction in the United States: it might shed light on the mysterious pattern of neutrino masses and give the first indication of a non-zero neutrino-oscillation phase. An adequate understanding of this new physics, however, will certainly require even more ambitious experiments, and new proposals are being developed around the world. We have a long way to go yet, but measuring θ_{13} shows that we are on the right road. ❐

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References

1. An, F. P. *et al.* Preprint at http://arXiv.org/abs/1203.1669 (2012).
2. Ank, J. K. *et al.* Preprint at http://arXiv.org/abs/1204.0626 (2012).
3. Abe, K. *et al. Phys. Rev. Lett.* **107,** 041801 (2011).
4. Adamson, P. *et al. Phys. Rev. Lett.* **107,** 181802 (2011).
5. Wark, D. *Nature* **421,** 485–486 (2003).

ASTROPHYSICS

A layered history

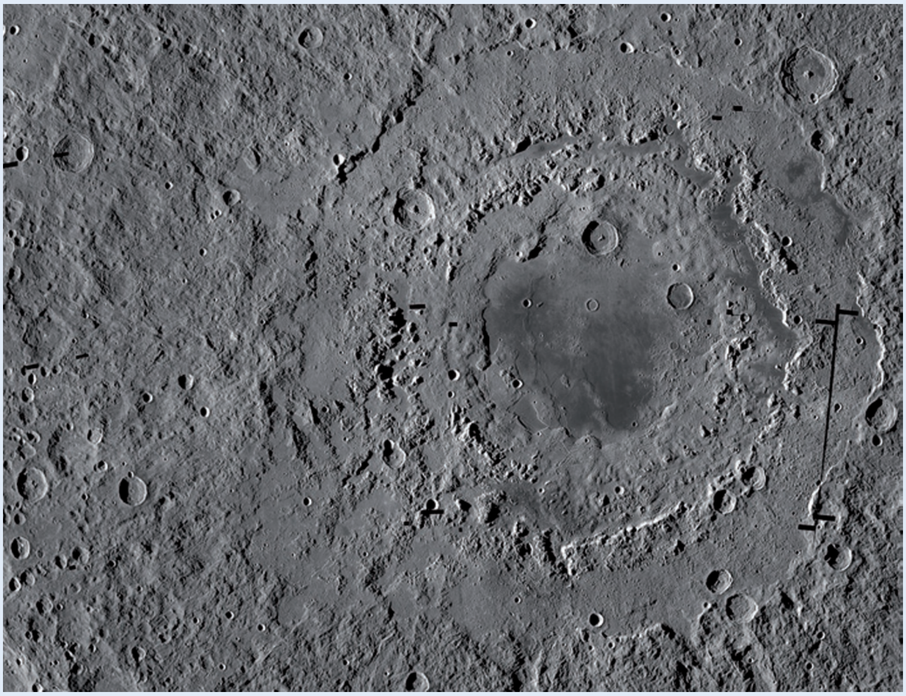
Reconstructing the history of terrestrial asteroid impact is more complex than simply cataloguing crater formation. For a start, craters offer little in the way of accurate temporal information, as they are obscured by geological and meteorological interference. Instead, the most useful information may be contained in the spherule layers that settle from the plume of vapour that results upon collision — as two studies now demonstrate.

The period during which many young lunar basins were created is generally thought to have ended nearly four billion years ago, around the time that the Orientale basin (pictured) was formed. But the Earth-bound evidence for impacts of similar size ties these events to more recent times — some as late as two billion years ago. In search of a plausible source for such bombardment, William Bottke and co-workers tracked asteroid trajectories using a model that implicates giant-planet migration as the disturbance that nudged asteroids from a prominent belt into planet-crossing orbits (*Nature* http://dx.doi.org/10.1038/nature 10967; 2012).

The study revealed that the blitz responsible for creating the lunar basins lasted much longer than previously thought. By extrapolating data from the survivors of the belt featured in the model, Bottke *et al.* were able to infer the probable ages of lunar and terrestrial basins. Their inferences are consistent with both known spherule-bed data and the characteristics of lunar craters.

In terms of probing the details of these large ancient impact events, spherule layers have yet more to offer. In another study, Brandon Johnson and Jay Melosh have characterized the details of impactors using the thickness of the spherule layers themselves (*Nature* http://dx.doi.org/10.1038/nature10982; 2012). They derived an equation relating layer thickness to the size of culprit asteroids and tested its accuracy by comparing their results with existing methods for determining impactor size. They found that they could also determine impact velocity from the average size of spherules — and reconstruct a chronology that documents the decline of impactor flux over the period on which Bottke *et al.* focus.

Together, the studies point towards an enriched understanding of the ancient history of asteroid impact, which makes good use of the clues that the blasts left behind.



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