First Juno science results supported by University of Leicester's Jupiter 'forecast'

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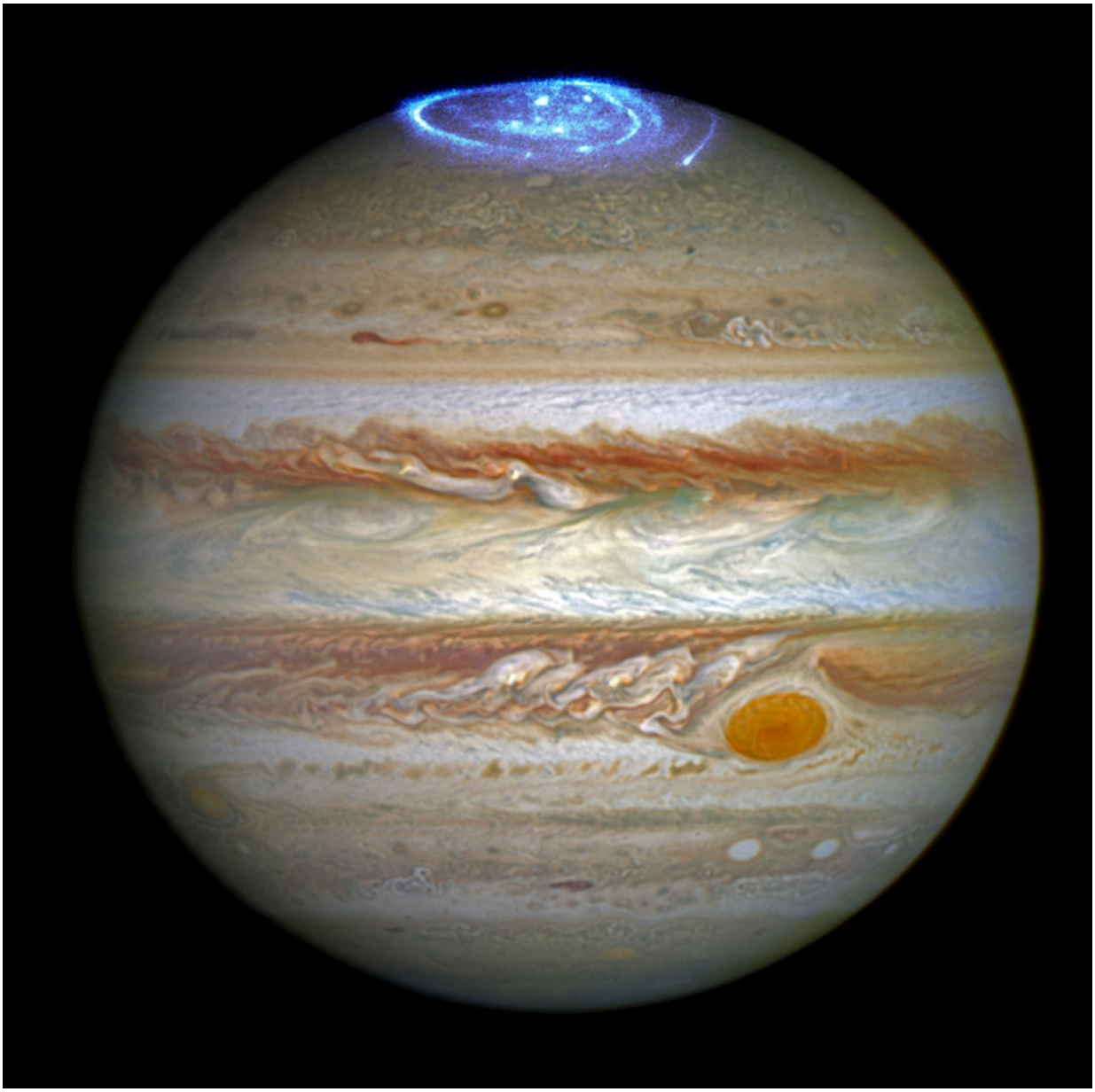

This image combines an image taken with Hubble Space Telescope in the optical (taken in spring 2014) and observations of its auroras in the ultraviolet, taken in 2016. Credit: NASA, ESA and J. Nichols (University of Leicester)

New observations about the extreme conditions of Jupiter's weather and magnetic fields by University of Leicester astronomers have contributed to the revelations and insights coming from the first close passes of Jupiter by NASA's Juno mission, announced today (25 May).

The astronomers from the University's Department of Physics and Astronomy, led by the UK science lead for the Juno mission, have led three papers and contributed to four papers in *Geophysical Research Letters*, a journal of the American Geophysical Union, that support the first in-depth science results from Juno published in the journal *Science*.

Juno made its first scientific close-up, known as a 'perijove', on 27 August last year. Lasting a few hours, the spacecraft flies from the north pole to the south pole, dipping within 4000 km of the equatorial clouds and beneath Jupiter's most intense and damaging radiation belts.

The Juno team organized a campaign with astronomers using Earth- and space-based telescopes around the globe to collaborate with the Juno science team. These collaborations provide the Juno science team with a 'forecast' of the gas giant's intense weather systems and powerful aurorae to compare with Juno close observations.

The results from Juno have proven Jupiter to be an even more extreme and surprising environment than the scientists predicted.

A model of the workings of Jupiter's polar aurorae (northern lights) was detailed by Professor Stan Cowley, Professor of Solar Planetary Physics

at University of Leicester and the UK science lead for Juno, with colleagues at the University of Leicester. This model, based upon spacecraft flybys and Galileo orbiter observations, details the electric currents which couple the polar upper atmosphere to the planetary field and plasma at large distances, and offers a comparison of Juno's early data with a prediction of what Juno would observe on its first 'perijove'.

Professor Cowley, who is a co-author on the *Science* paper, said: "Our new paper in the Juno special issue of *Geophysical Research Letters* makes detailed predictions about what should be seen, and when, on Juno's first perijove pass, and we plan to continue this work for subsequent passes as well. Our prediction is being published alongside the early Juno data. We look forward to future release of the fully calibrated Juno data that will allow these predictions to be tested in detail."

Dr Jonathan Nichols, Reader in Planetary Auroras at University of Leicester, was also involved in monitoring Jupiter's polar aurorae during Juno's approach to Jupiter. He led on observations of the impact of the solar wind on the auroras using the Hubble Space Telescope, for the first time confirming the impact of the solar wind on auroras on Jupiter - and capturing the most powerful auroras observed by Hubble to date.

Dr Nichols said: "Jupiter threw an auroral firework party to celebrate Juno's arrival. We have been able to show that intense pulses of aurora were triggered during intervals when the solar wind was buffeting the giant magnetosphere. This tells us that even Jupiter's mighty magnetosphere is, like those of Earth and Saturn, not immune to the vagaries of the Sun and the solar wind."

Dr Leigh Fletcher, Royal Society Research Fellow at University of Leicester, has led Earth-based observations of Jupiter's atmospheric weather systems which take the form of dark and light banding of colour

as seen from Earth. Closer inspection using the Very Large Telescope in Chile, the Subaru Telescope in Hawaii, and NASA's Infrared Telescope Facility (IRTF) reveals that this banding is constantly changing over long spans of time. Juno is starting to reveal the deep processes driving these changes from below the clouds.

Dr Fletcher said: "Juno's data shows that Jupiter exhibits banding all the way down to ~350km, much deeper than what we've generally thought of as Jupiter's 'weather layer' in the upper few tens of kilometres. Deep sounding down through the clouds for the first time has revealed an enormous circulation pattern with a column of rising equatorial gas, suggesting that those cloud-top colours really are just the tip of the iceberg. This is much deeper than we can see with Earth- or space-based telescopes.

"The presence of the Juno spacecraft in orbit around Jupiter is providing us with an unprecedented opportunity to combine remote observations with in situ studies of the jovian environment, a chance that won't come again for at least a decade. Already, Juno's discoveries are forcing us to re-evaluate some long-standing ideas about how this giant planet system works."

Juno launched on 5 Aug 2011, from Cape Canaveral Air Force Station, Florida, and arrived in orbit around Jupiter on 4 July 2016. In its current exploration mission, Juno soars low over the planet's cloud tops, as close as about 2,100 miles (3,400 kilometers). During these flybys, Juno probes beneath the obscuring cloud cover of Jupiter and studies its auroras to learn more about the planet's origins, structure, atmosphere and magnetosphere.

The University of Leicester is home to the UK science lead for the Juno mission, NASA's programme to study our solar system's largest planet, Jupiter. Planetary scientists and astronomers from the Department of

Physics and Astronomy are studying the gas giant's magnetosphere, dynamic atmosphere and its beautiful polar auroras.

More information: L. N. Fletcher, Cycles of Activity in the Jovian Atmosphere, *Geophysical Research Letters* (2017). DOI: 10.1002/2017GL073806

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