Candidate most massive binary star identified

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Hubble Space Telescope picture of the 30 Doradus star forming region in the Large Magellanic Cloud. The double massive star R144 is indicated by an arrow. This star weighted at birth 300 to 400 solar masses. The present-day mass of the two star is between 200 and 300 times the mass of our Sun, which makes the system potentially the most massive double star known to date. Slightly left from the image center can one finds the massive central star cluster R136. Credit: NASA, ESA, D. Lennon and E. Sabbi (ESA/STScI), J. Anderson, S. E. de Mink, R. van der Marel, T. Sohn and N. Walborn (STScI), N. Bastian (Excellence Cluster, Munich), L. Bedin (INAF, Padua), E. Bressert (ESO), P. Crowther

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Astronomers have observed a binary star that potentially weighed 300 to 400 solar masses at birth. The present day total mass of the two stars is between 200 and 300 times that of the Sun, depending on its evolutionary stage, which possibly makes it the most massive binary star known to date. The results of this study, which was led by astronomer Hugues Sana of the University of Amsterdam and bachelor student Tayo van Boeckel, have been published in *Monthly Notices of the Royal Astronomical Society Letters*.

The massive binary star R144 can be found in an outer area of the star-forming region 30 Doradus in the Large Magellanic Cloud. A number of particularly bright stars can be found in the center of that region with a characteristic pattern of spectral lines. The masses of these so-called Wolf-Rayet stars are up to 250 times the mass of the Sun. R144 is the visually brightest light source of this type in the star-forming region 30 Doradus and radiates strongly in X-rays. This was an indication that R144 is a binary star. This presumption has now been confirmed thanks to the discovery of periodic (orbital) changes in the spectrum.

Spectra of R144 have been obtained with the X-shooter spectrograph on the Very Large Telescope of the European Southern Observatory. X-shooter is one of the most sensitive spectrographs on Earth and can observe light from the near-ultraviolet to the near-infrared in one shot. "The identification of this candidate would have been a great challenge without X-shooter. This spectrograph makes observations a lot easier and much more efficient, especially because less observation time is required to cover a large spectral range," explains Sana.

The spectrum forms the fingerprint of a star. From the changing shape and position of the spectral lines it becomes clear that R144 is a binary star. The spectral lines also suggest that the binary system is formed by two hydrogen-rich Wolf-Rayet stars with similar masses, and a current total mass of 200 to 300 solar masses. NGC 3603-A1 was formerly known as the most massive binary star, with a total mass that is equal to 212 times the mass of the Sun.

"It is a mystery how extremely massive stars form," explains co-author Frank Tramper (University of Amsterdam). "According to the most widely accepted theories, stars of hundreds of solar masses can only form in massive star clusters. The fact that R144 lies far out from the central star cluster in 30 Doradus is possibly an indication that these systems can form in isolation."

"There is an alternative scenario for the formation of R144," says co-author Alex de Koter (University of Amsterdam), "namely, that R144 was formed in the central star cluster, but that it was ejected by dynamical interactions with other massive stars." The team is already working on follow-up observations to determine whether R144 is indeed a 'runaway' star, to definitively establish its mass and its other physical properties, in order to decide whether R144 really is the most massive double star discovered so far.

More information: H. Sana, T. van Boeckel, F. Tramper, L. E. Ellerbroek, A. de Koter, L. Kaper, A. F. J. Moffat, O. Schnurr, F. R. N. Schneider and D. R. Gies 'R144 revealed as a double-lined spectroscopic binary', *Monthly Notices of the Royal Astronomical Society Letters*, 27 March 2013. mnrasl.oxfordjournals.org/cont … 1.slt029.short?rss=1

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