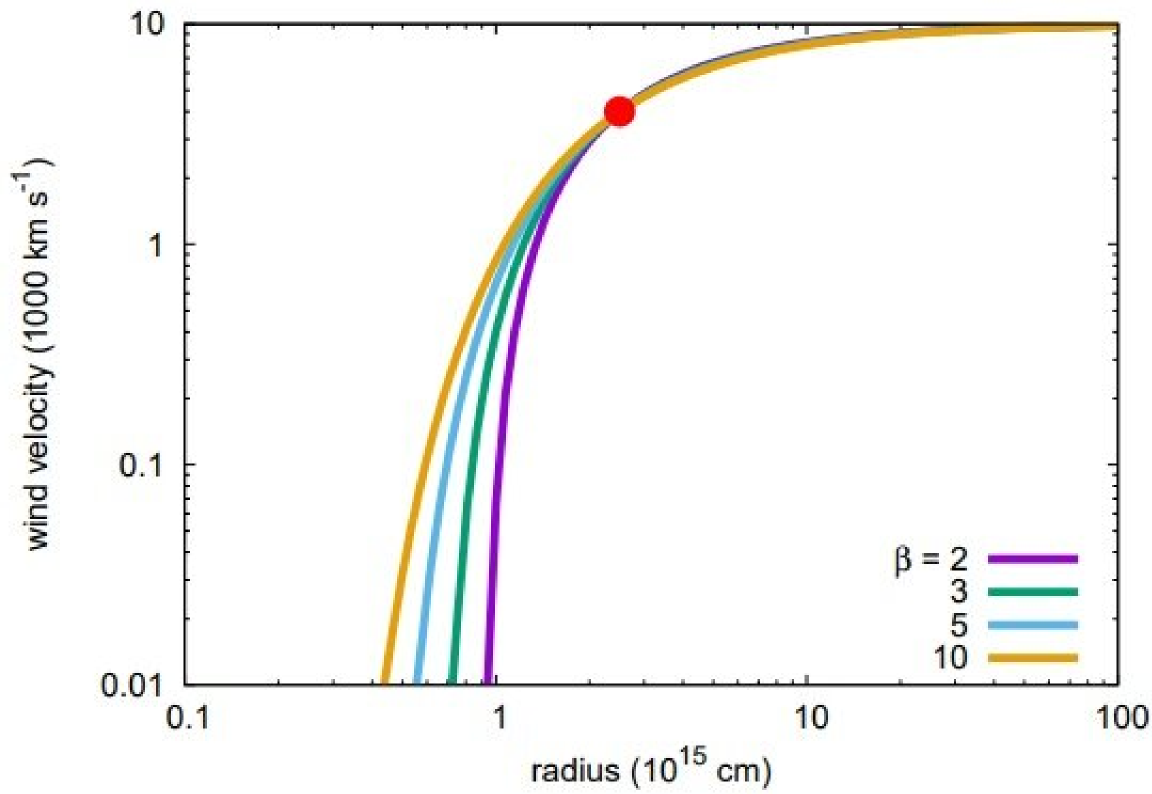
IPTF14hls may be a variable hyper-wind from a very massive star, study suggests

November 14 2019, by Tomasz Nowakowski



Possible wind velocity structure in iPTF14hls. Credit: Moriya et al., 2019.

A source known as iPTF14hls, assumed to be a Type IIP supernova, may be a long-term outflow similar to stellar winds, according to a new study published November 5 on arXiv.org. The new research proposes that iPTF14hls is most likely a so-called "hyper-wind"—an extreme mass outflow from a massive star.

Discovered in September 2014 by the Intermediate Palomar Transient Factory, iPTF14hls is believed to be an unusual Type IIP supernova star that erupted continuously for about 1,000 days before becoming a remnant nebula. Given that typical Type IIP supernovae dim in about 100 days, the behavior of iPTF14hls still baffles astronomers.

Many hypotheses have been proposed that may explain the true nature of iPTF14hls. Some studies suggest that the object could be a pulsational pair-instability supernova, while some point out to a magnetar. Other scenarios taken into account are that iPTF14hls could represent a shock interaction of ejected material with dense circumstellar material or even an antimatter burning in a stellar core. However, none of the presented hypotheses fully explains all the aspects of this source.

A team of astronomers led by Takashi J. Moriya of National Astronomical Observatory of Japan (NAOJ) has revealed their own theory. By analysing the available observational data of iPTF14hls, they found that this object may be related to an extreme, long-term mass outflow from a massive star rather than a violent, short-term mass ejection like a supernova.

"We here propose that iPTF14hls was not a sudden outburst like supernovae, but rather a long-term outflow similar to stellar winds," the astronomers wrote in the paper.

The authors of the paper argue that the properties of iPTF14hls seems to prove that it is a stellar wind with variable mass-loss rate. They underlined that the slow change in the source's spectroscopic properties over two years could be naturally explained by such a continuous wind.

According to the study, the total kinetic energy of this outflow may be around 10 sexdecillion erg, which is much higher than the standard supernova explosion energy of around 1.0 sexdecillion erg. However, it remains unclear how the progenitor, with an estimated mass not exceeding 150 solar masses, gained such a huge amount of energy to drive this hyper-wind.

The research found that the mass-loss rates exceed a few solar masses per year during the bright phase of iPTF14hls and temporarily become as high as even 10 solar masses per year. This resulted in the loss of about 10 solar masses over two years.

Moreover, the extremely high luminosity of iPTF14hls also suggests that it is hyper-wind. The researchers describe it as a super-Eddington continuum-driven wind in which the hydrogen recombination likely powers the early bright phase of iPTF14hls.

"Given the extremely large luminosity far beyond the Eddington luminosity, the wind is probably driven by radiation as suggested for η Carinae and other luminous blue variables," the astronomers concluded.

More information: iPTF14hls as a variable hyper-wind from a very massive star, arXiv:1911.01740 [astro-ph.HE] arxiv.org/abs/1911.01740

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