

THE PRODUCTION OF STRONG, BROAD HeII EMISSION AFTER THE TIDAL DISRUPTION OF A MAIN SEQUENCE STAR BY A SUPERMASSIVE BLACK HOLE



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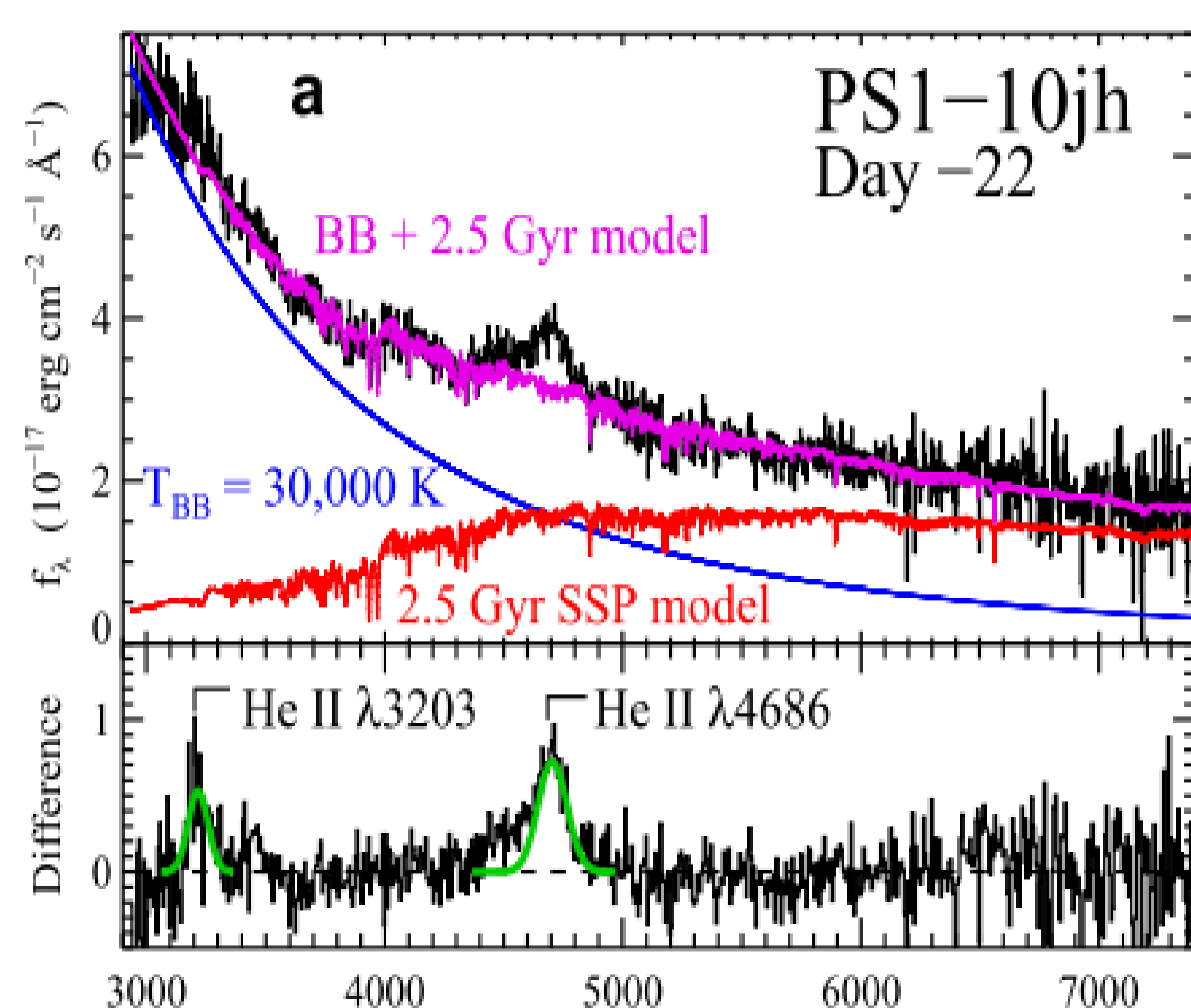


Abstract

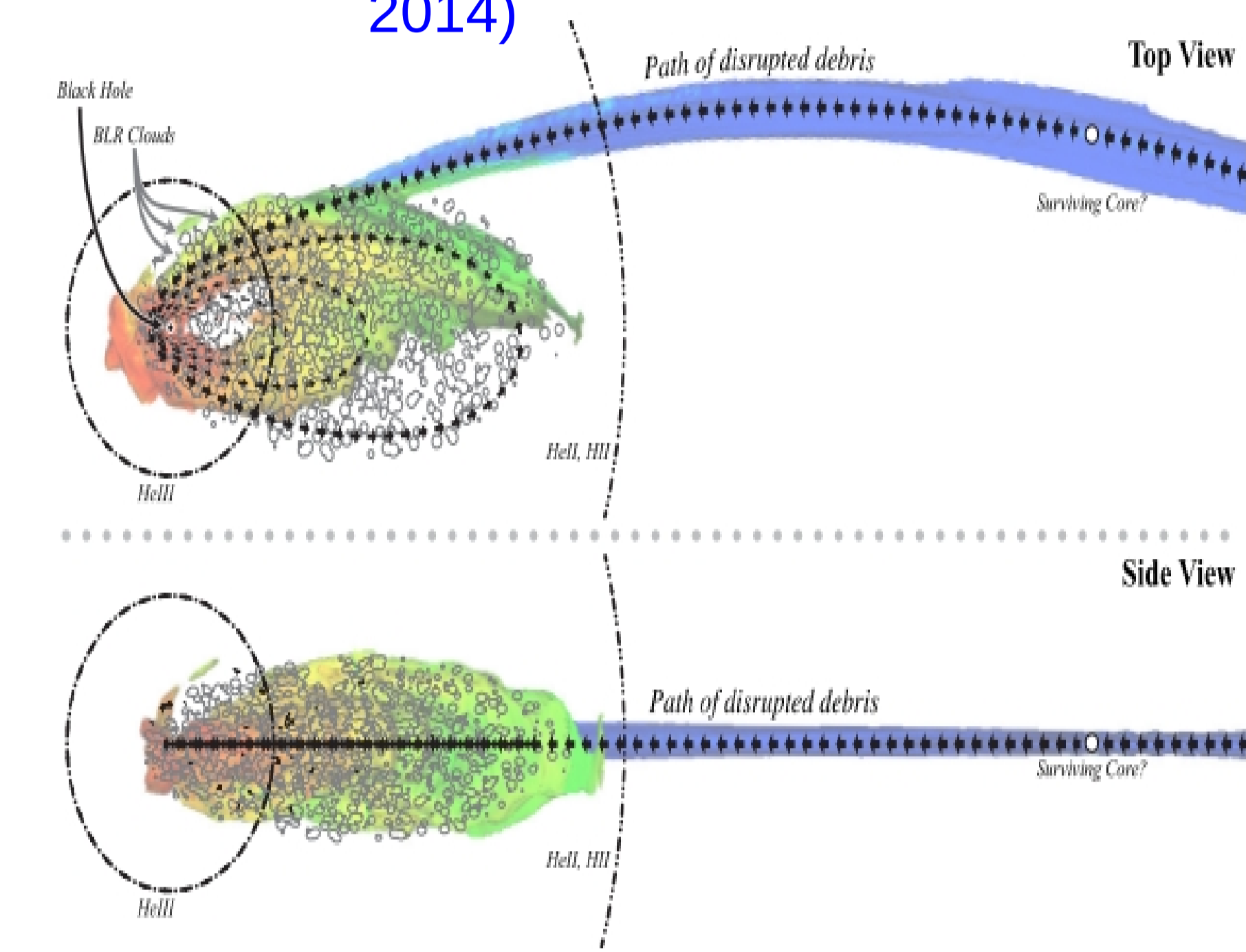
The tidal disruption event (TDE) PS1-10jh lacked strong Balmer lines but showed strong, broad, He II emission both before maximum light and for at least 8 months thereafter. Gezari et al. (2012) interpreted this as evidence for the disruption of a rare hydrogen-deficient star. However, Guillochon et al. (2014) have argued instead that the disrupted star was a normal main-sequence star and that the strength of the He II emission compared with the Balmer lines is a result the emission being similar to the broad-line region (BLR) of an AGN, but lacking the outer, lower-ionization BLR gas. We show that the profile of He II $\lambda 4686$ in PS1-10jh is similar to the blueshifted profiles of high-ionization lines in AGNs. The similarity of the He II $\lambda 4686$ emission in PS1-10jh to the emission from the inner BLRs of AGNs supports the idea that the emission after a TDE event is similar to that of normal AGNs.

The best-observed Tidal Disruption Event (TDE) to date: PS1-10jh

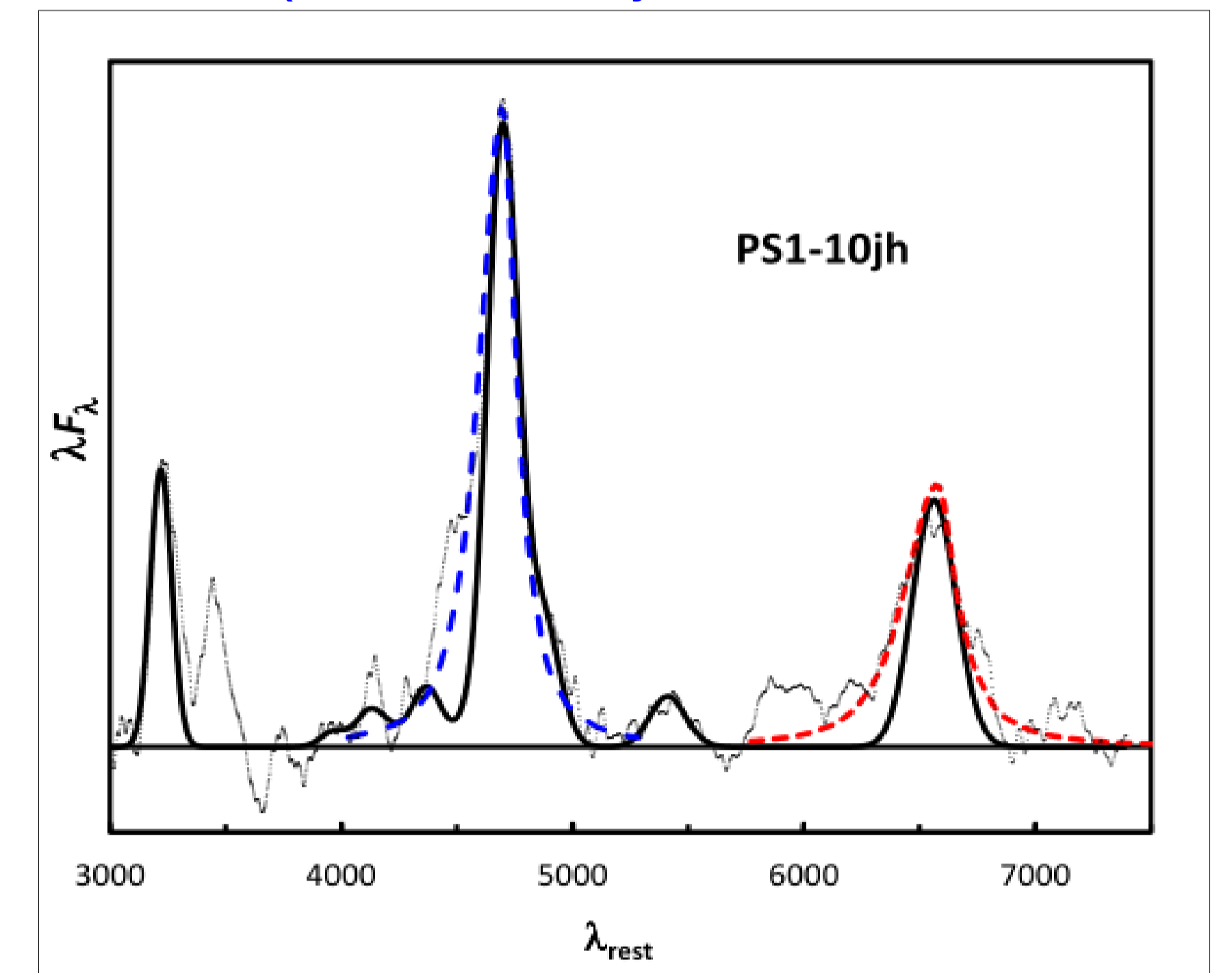
(Gezari et al. 2012)



(Guillochon et al. 2014)



(Gaskell & Rojas Lobos)



The spectrum is dominated by broad He II $\lambda 4686$ emission, rather than the expected hydrogen lines. Gezari et al (2012) therefore proposed that it was the disruption of a stripped helium core of a red giant.

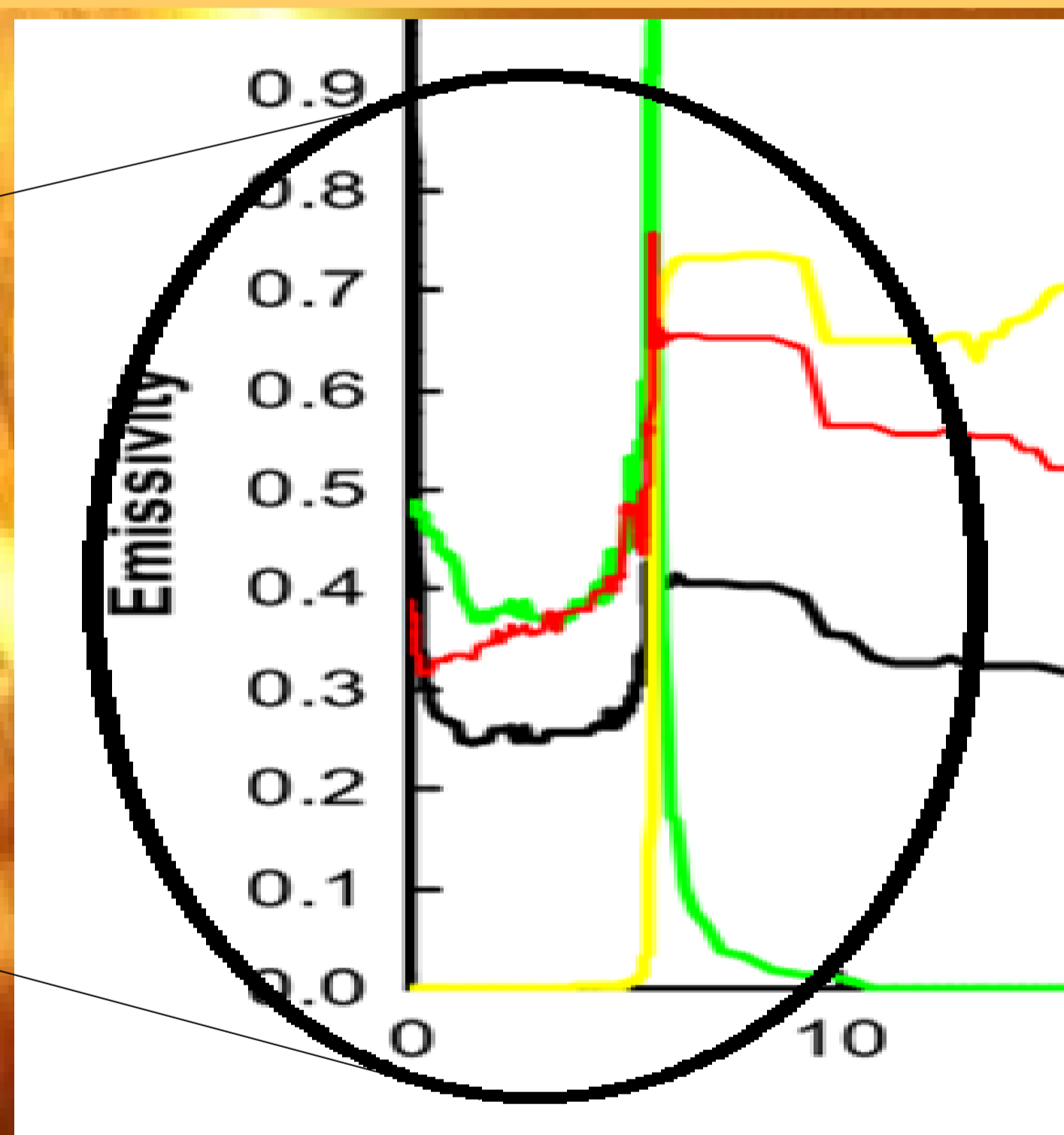
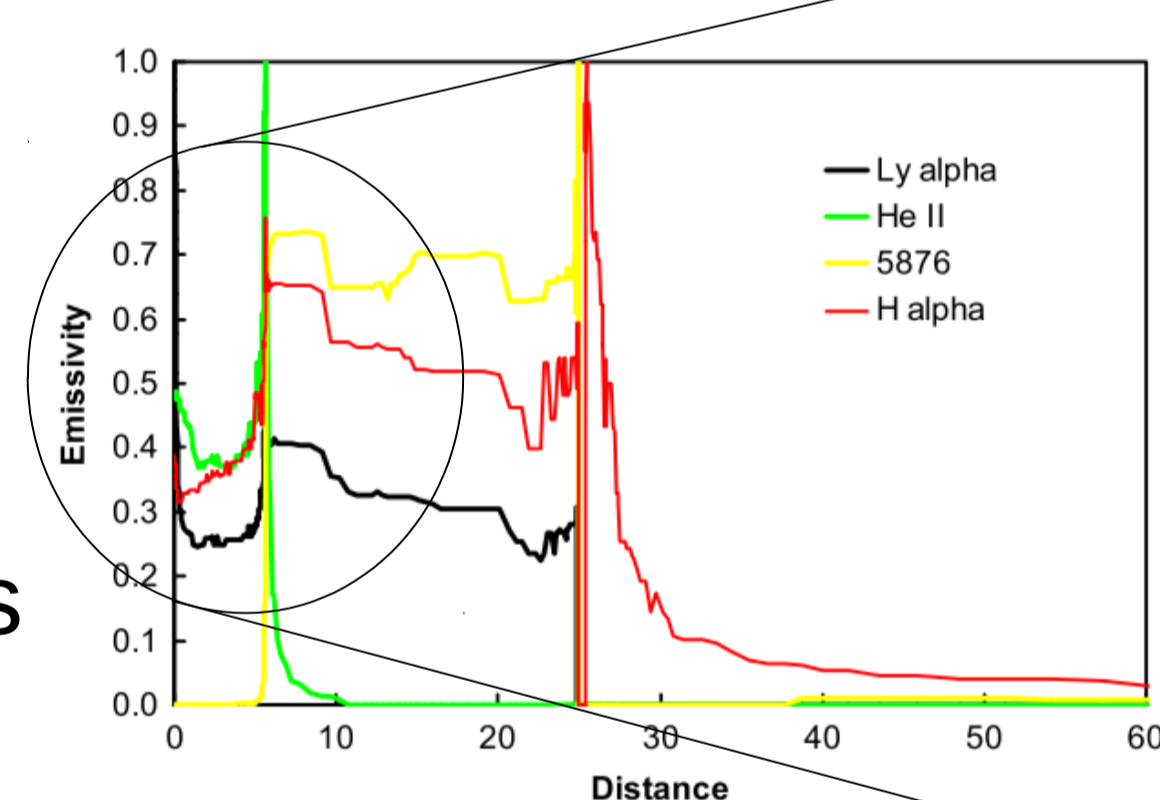
Guillochon et al. (2014) argue that the disruption of a helium star is unlikely and that the emission of PS1-10jh comes from a truncated broad Line region (BLR) formed after a tidal disruption.

We have derived the HeII $\lambda 4686/H\alpha$ ratio from the pre-maximum light spectra of the candidate TDE PS1-10jh and shown that the HeII $\lambda 4686$ is similar to the blueshifted high-ionization BLR lines of normal AGNs.

Truncated BLR

BROAD LINE REGION (BLR) OF A NORMAL AGN

The broad-line region (BLR) of an AGN is a flattened structure that has highly radially-stratified ionization (Gaskell 2009).

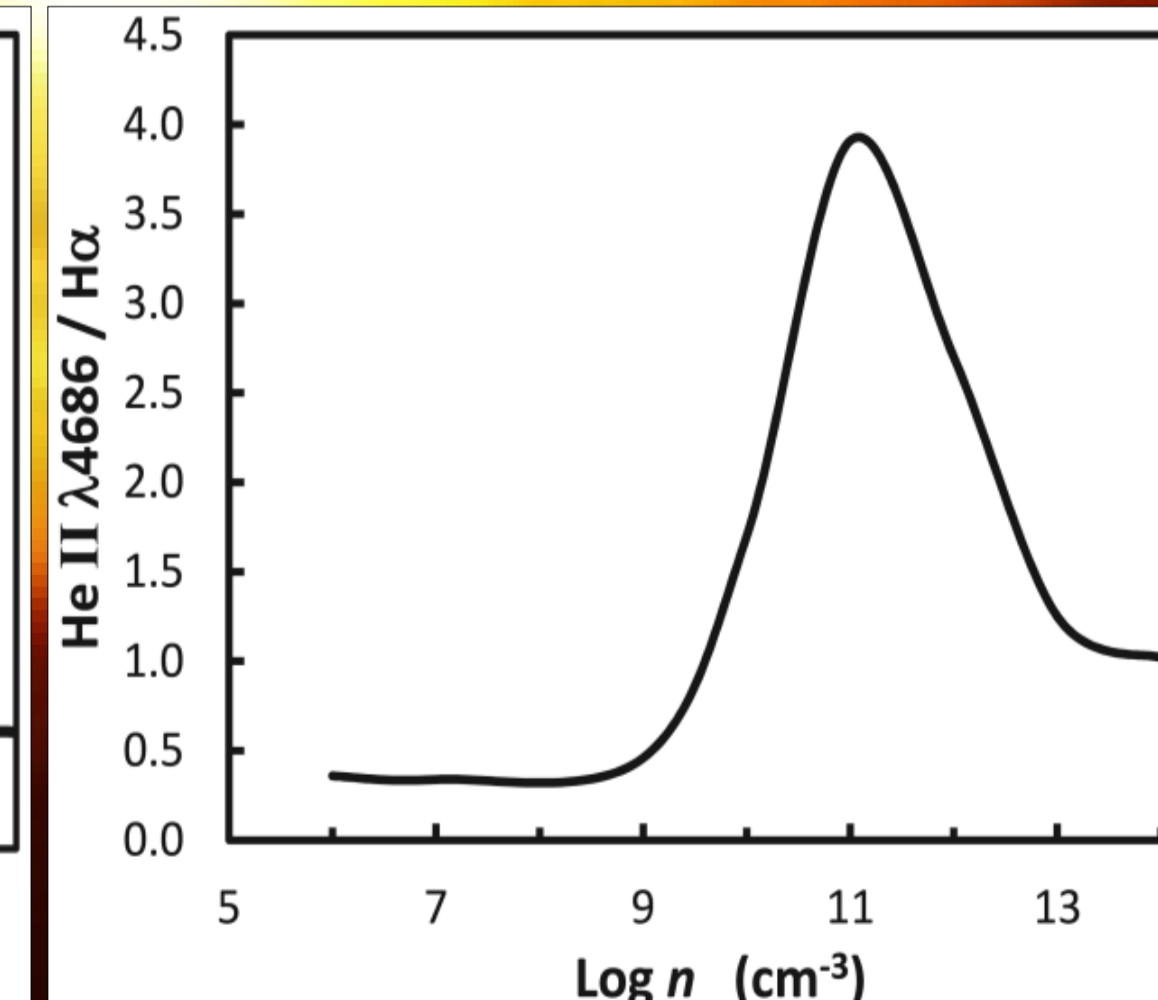
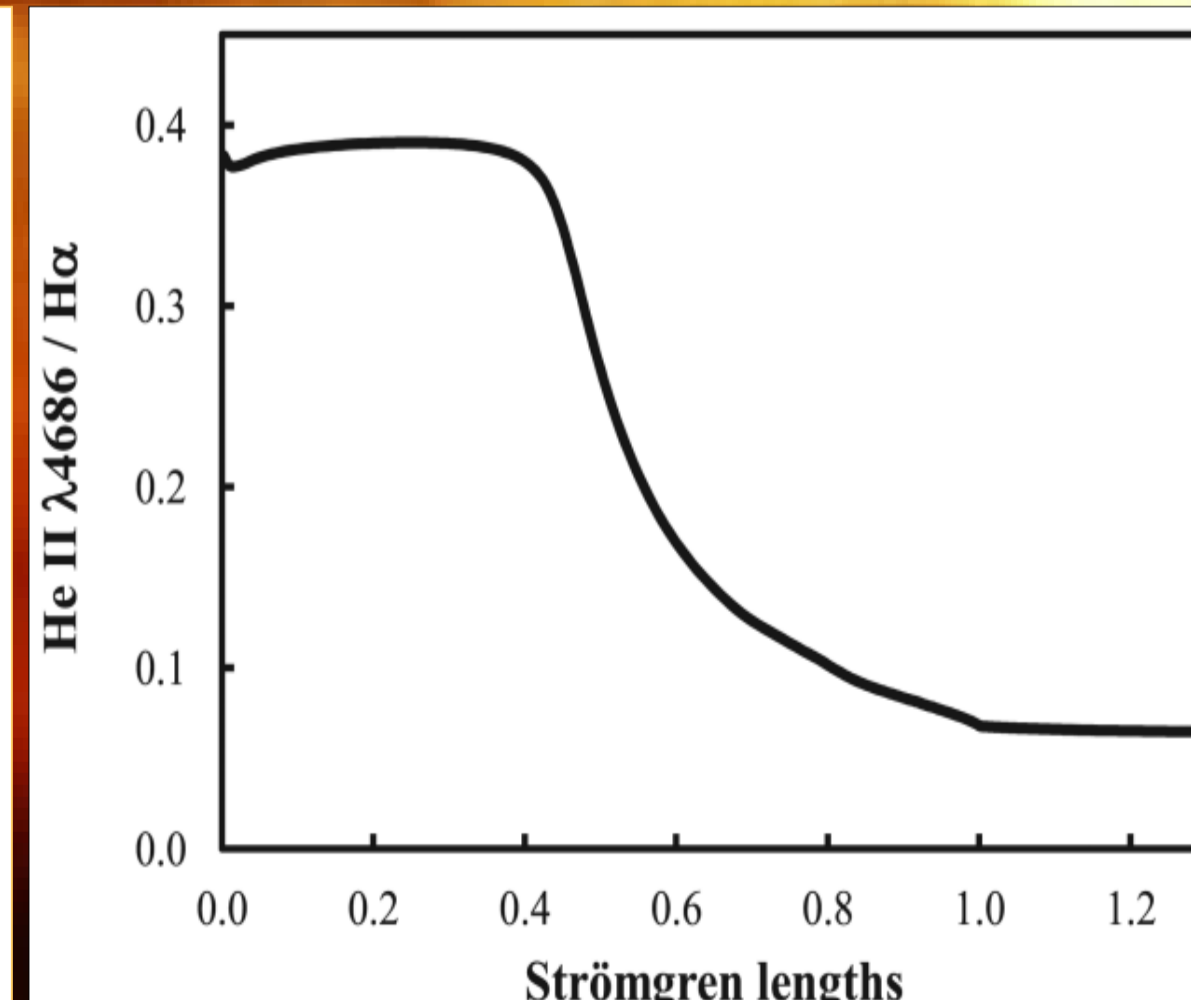


We assume that a BLR forms above the temporary accretion disc that forms as material from the disrupted star is accreted by the black hole.

We used the photoionization code CLOUDY 13.02 (Ferland et al. 2013) and the Mathews & Ferland (1987) representation of an AGN ionizing continuum to see if photoionization of a gas with approximately solar abundances can reproduce the HeII/H α

Results

We show here (left figure) how the HeII $\lambda 4686/H\alpha$ ratio varies with the column density of the gas. The ratio is a maximum when the BLR is truncated before He⁺⁺ becomes He⁺.



We find that the observed extremely high HeII $\lambda 4686/H\alpha$ ratio can be produced with solar abundances for densities $> 10^{11} \text{ cm}^{-3}$ (see right figure). The ratio is insensitive to the ionization parameter.

Discussion and Conclusions

We find that a high HeII $\lambda 4686/H\alpha$ ratio can indeed be produced with a truncated BLR and solar abundances as proposed by Guillochon et al. (2013) so long as there is a high density. A He star is not necessary. The reason the BLR is truncated is because in an AGN the BLR is associated with the accretion disc and the disc after a TDE is limited in radius because, unlike a normal thermal AGN, there is no torus to keep resupplying the outer disc.

References:

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