The planet around the millisecond pulsar J1719-1438

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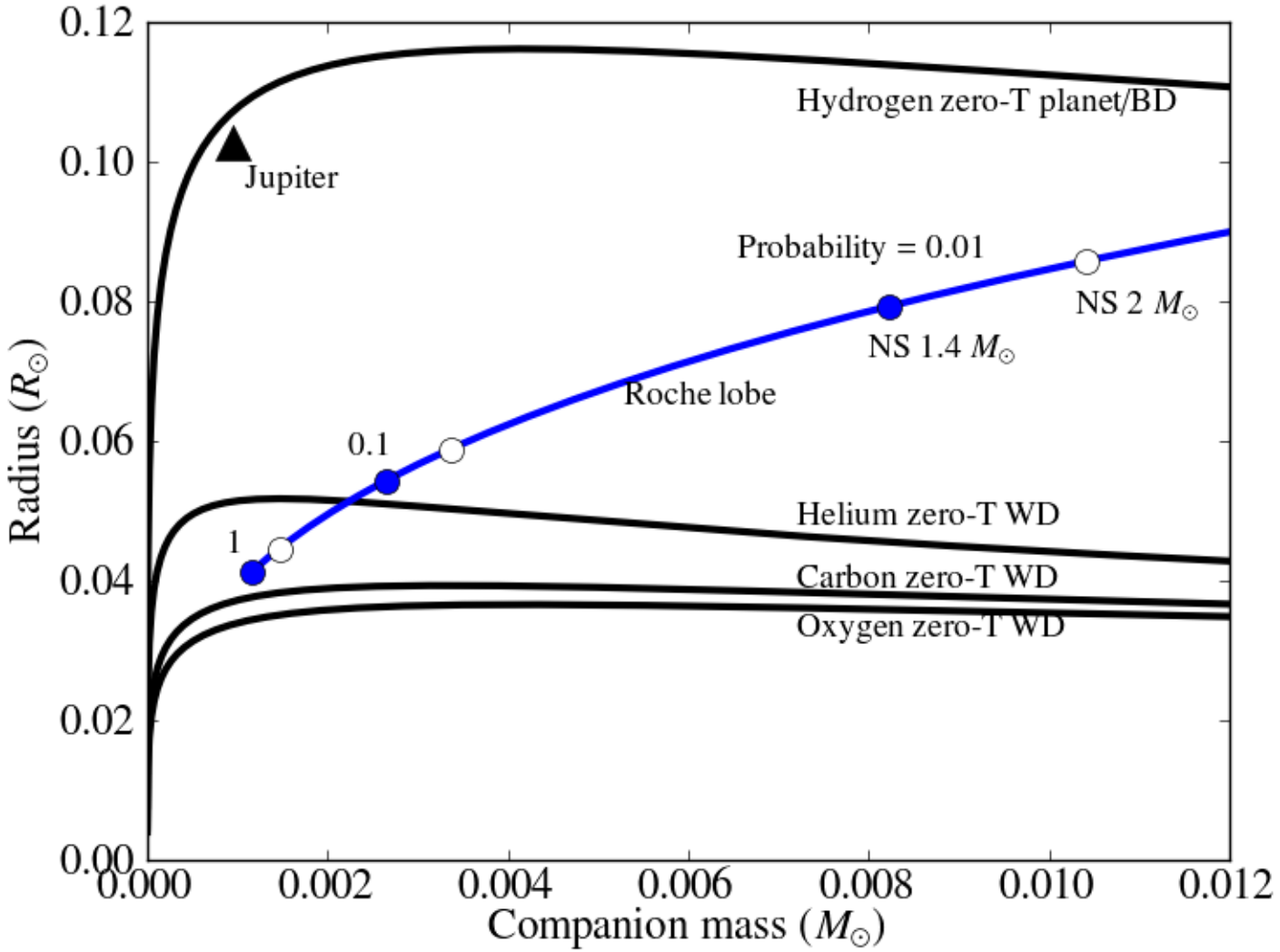
What we know about PSR J1719-1438

- Companion in a 2.2 hour orbit
- Companion is detached, average density > 23 g/cm^3
- Mass function: companion mass > 1.16 x 10^{-3} Msun
- Pulsar spin period of 5.8 ms

Data from Bailes et al. 2011, Science, 333, 1717
Titleslide image: Rasio 2011, Science, 333, 1712

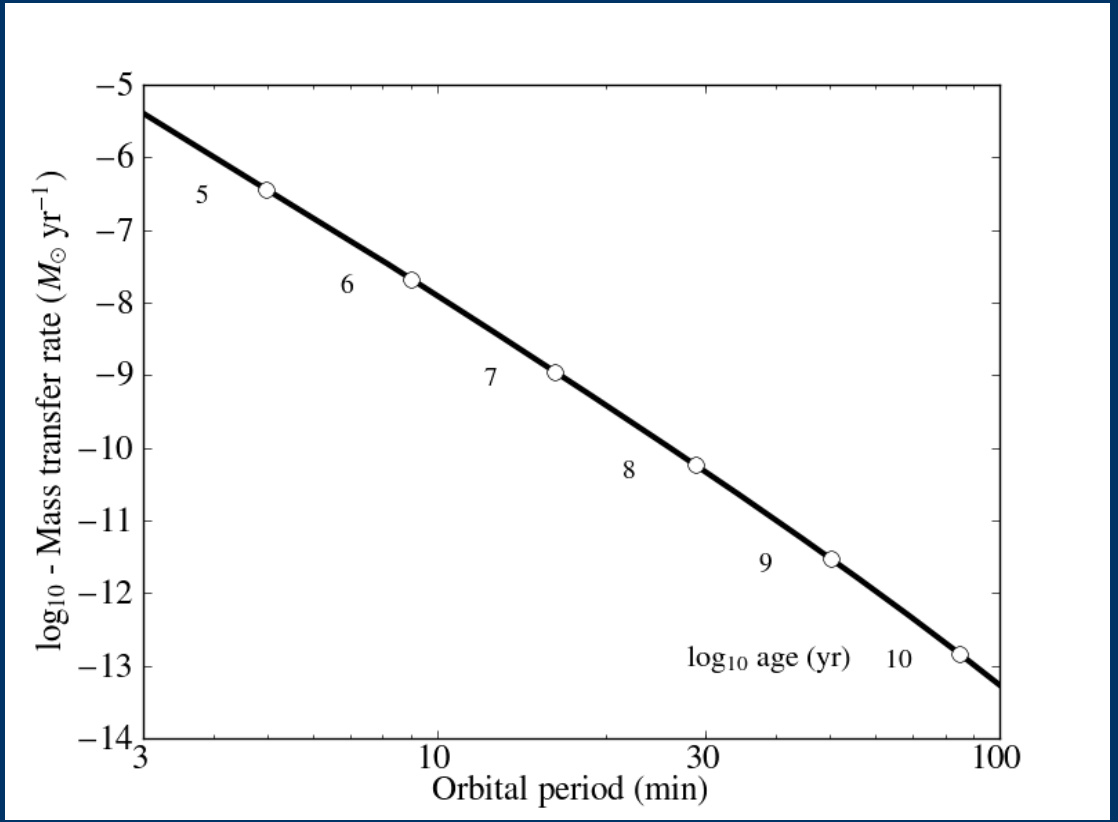
Constraints on companion composition



van Haaften, Nelemans, Voss & Jonker 2012, A&A, 541, A22

Ultracompact X-ray binaries (UCXBs)

- Roche-lobe filling white dwarf/ helium star losing mass to a neutron star
- Gravitational wave radiation forces mass transfer
- Orbit expands to ~80 minutes



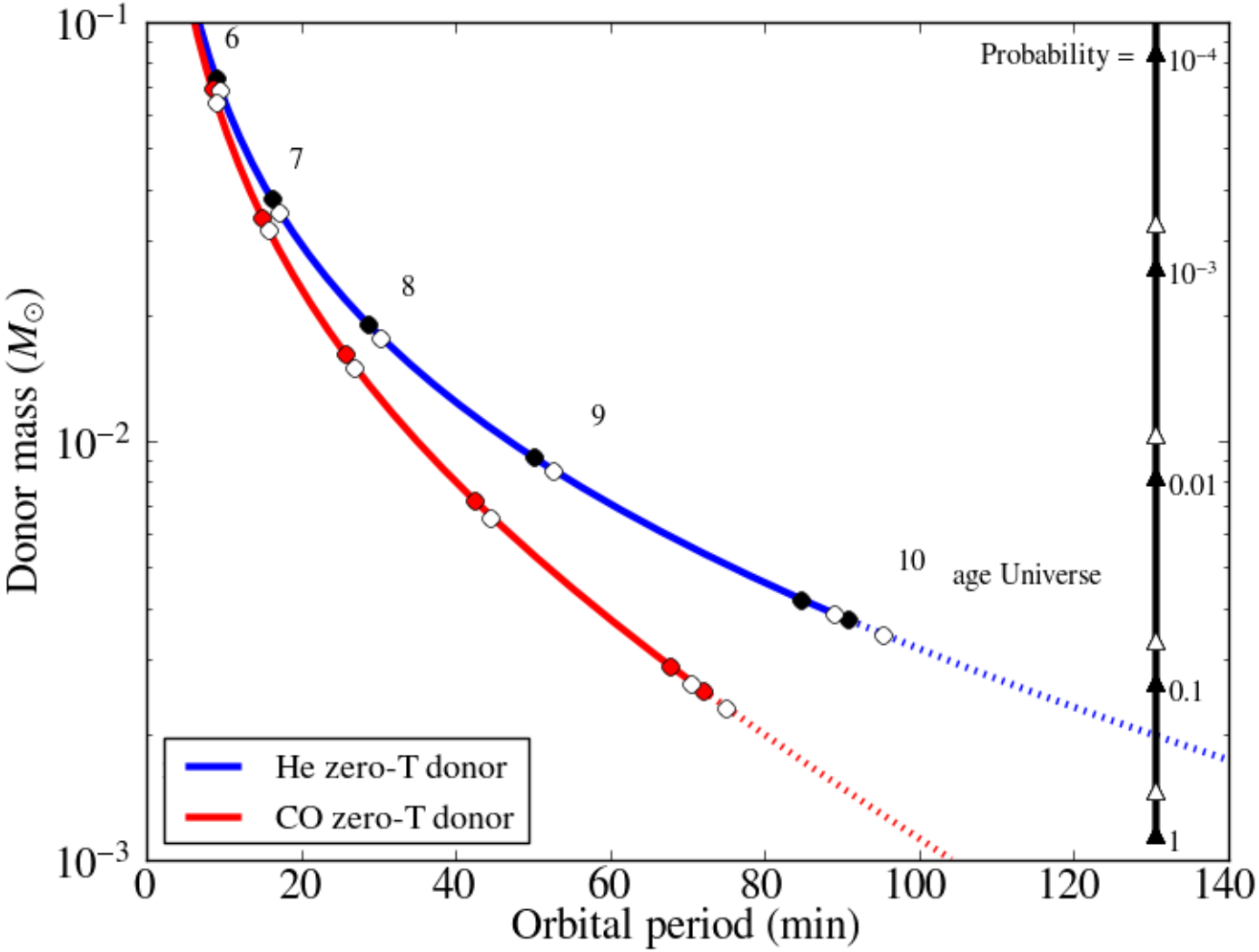
The UCXB scenario

The system J1719-1438 has probably evolved out of an UCXB, because:

- Millisecond pulsar
- High companion density
- Only 1 companion
- Relatively close orbit
- Circular orbit

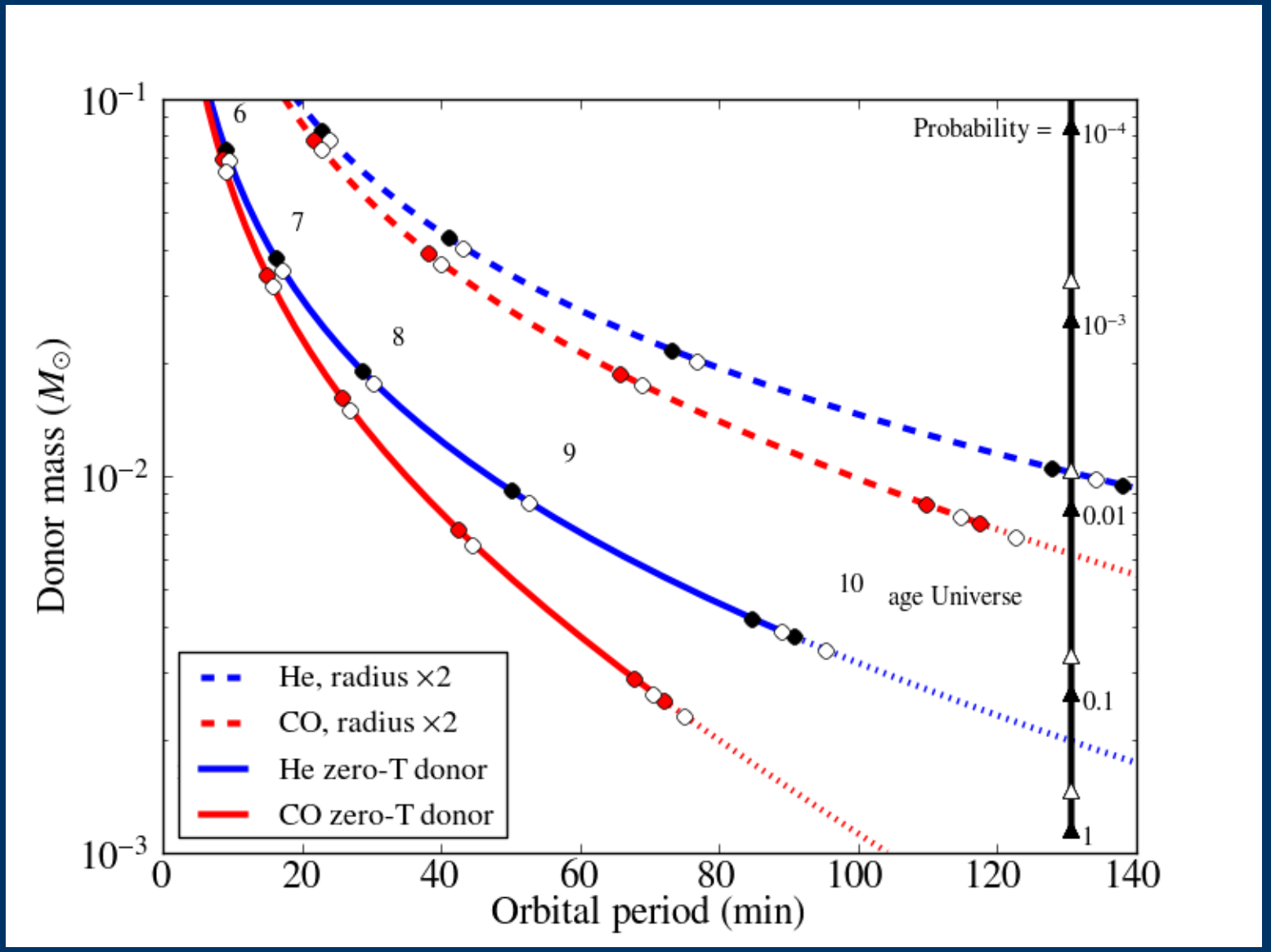
But there are complications!

UCXB evolutionary tracks



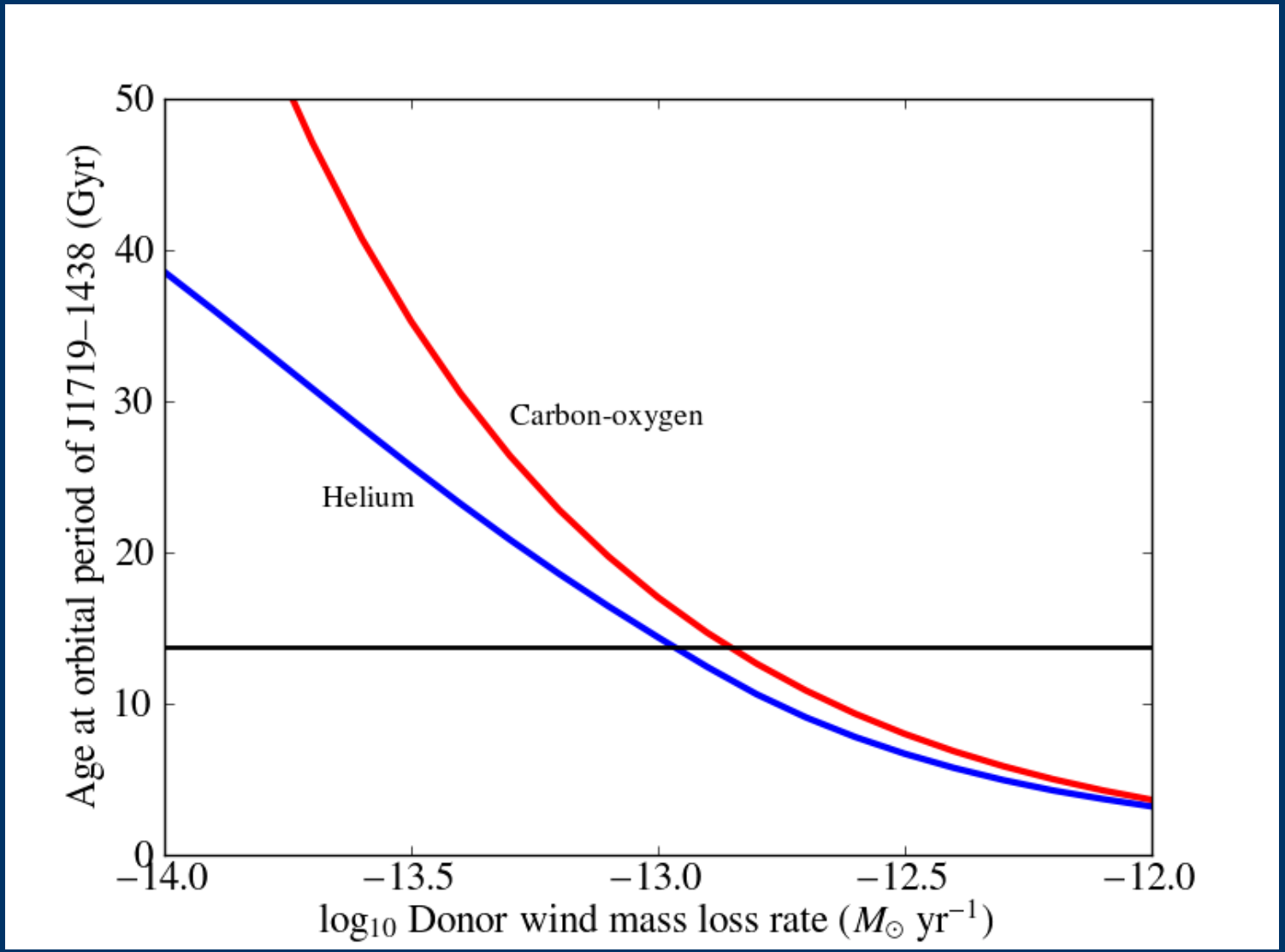
van Haaften, Nelemans, Voss & Jonker 2012, A&A, 541, A22

UCXB evolutionary tracks



van Haaften, Nelemans, Voss & Jonker 2012, A&A, 541, A22

Evolution accelerated by extra angular momentum loss



van Haaften, Nelemans, Voss & Jonker 2012, A&A, 541, A22

The detached state

Qualitative explanations:

- Donor has shrunk too fast for orbital shrinking to keep up, perhaps due to decreasing irradiation from pulsar
- Donor has lost heated outer layers due to wind, leaving a less bloated remnant

Conclusion

- The properties of J1719-1438 are consistent with a modified UCXB evolutionary history.

  A combination of

- Low inclination/ bloated donor
- Donor wind

  is sufficient, without requiring an improbable contribution of either.

- *More details: van Haaften et al. 2012, A&A, 541, A22*