The hard X-ray emission from colliding-wind massive binaries: a probe to investigate the physics of particle acceleration in massive stars

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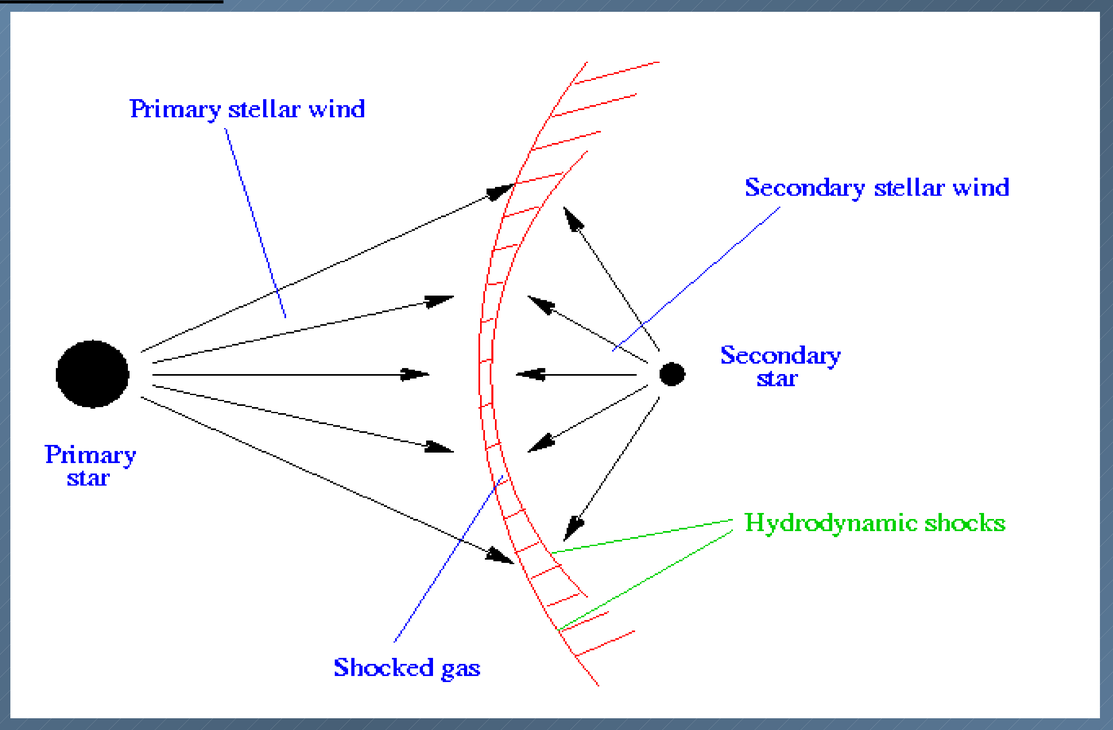
Colliding-wind massive binaries as particle accelerators:

More than 30 early-type stars (most are confirmed or suspected binaries) exhibit synchrotron radiation in the radio domain (see e.g. De Becker 2005)
⇒ evidence for the presence of relativistic electrons
⇒ particle acceleration is at work!
Acceleration process? Diffusive Shock Acceleration (DSA) mechanism in the presence of strong hydrodynamic shocks (see e.g. Pittard & Dougherty 2006 and Reimer et al. 2006)

In massive binaries, particle acceleration is expected to occur close to the shocks produced by the colliding winds



X-ray emission from colliding-wind massive binaries:

Revealed

- Plasmas of individual stellar winds ⇒ T of a few MK
- Shocked plasma of colliding winds ⇒ T up to a few tens of MK

} **Thermal** X-ray emission

Process: free-free + emission lines

Not yet revealed

- Relativistic electrons are accelerated
- Strong UV radiation field from the two stars

} **Non-thermal** X-ray emission

Process: inverse Compton scattering (power law)

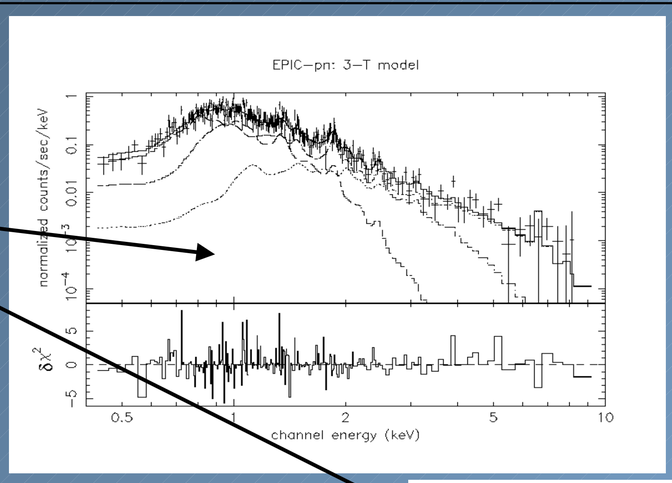
***Main issue*: the expected non-thermal component is weak w.r.t. the thermal contributions below 10 keV**

The detection of non-thermal X-rays?

- Results from the **XMM-Newton** campaign on non-thermal radio emitters: *The thermal contributions extend significantly up to about 10 keV ⇒ the putative non-thermal component is overwhelmed by the thermal ones (De Becker 2005)*
- Investigations with **INTEGRAL**? *The sensitivity is not good enough ⇒ no detection of non-thermal radio emitters above 20 keV (De Becker et al. 2007)*

A high sensitivity X-ray observatory such as XEUS is needed to detect non-thermal emission from massive binaries, with the strong requirement of a bandpass going above 10 keV!

Objective: understand the particle acceleration process in colliding-wind binaries, and its potential relation with the production of cosmic-rays, by putting constraints upon the high-energy emission from such systems (using e.g. the models of Pittard & Dougherty 2006 and Reimer et al. 2006)

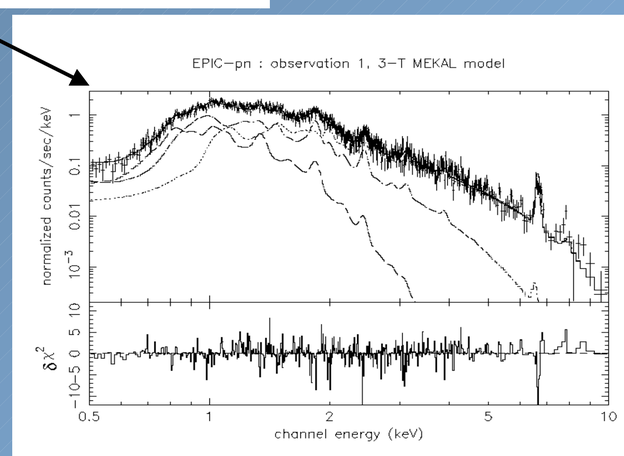


Ex.1: HD167971

- Triple system: O5-8V + O5-8V + O8If
- Strong thermal X-ray emission (De Becker et al. 2005)

Ex.2: Cyg OB2 #8A

- Binary system: O6.5If + O5.5III(f)
- Strong thermal X-ray emission (De Becker et al. 2006)



- De Becker M., 2005, PhD thesis, University of Liège
- De Becker M., Rauw G., Blomme R., et al., 2005 A&A, 437, 1029
- De Becker M., Rauw G., Sana H., et al., 2006, MNRAS, 371, 1280
- De Becker M., Rauw G., Pittard J.M., et al., 2007, A&A, submitted
- Pittard J.M. & Dougherty S.M., 2006, MNRAS, 372, 801
- Reimer A., Pohl M. & Reimer O., 2006, ApJ, 644, 1118