THE MYSTERIOUS COMPANION OF THE HOT SUBDWARF HD 49798

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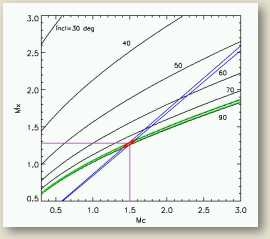
HD 49798 /RX J0648-4418 is the only X-ray binary pulsar with a mass donor of the hot subdwarf type.

The star HD 49798 is the optically brightest O-type subdwarf (V=8, $L=10^4\ L_\odot$) and its compact companion is either a neutron star or a white dwarf, as proved by the X-ray periodicity indicating a spin period of only 13.2 s.

With XMM-Newton we measured the pulse delays induced by orbital motion (P_{ORB}=1.55 days) and discovered the X-ray eclipse.



This allowed us to measure the masses of the two components:

1.50+/-0.05 $M_\odot$ for HD 49798

1.28+/-0.05 $M_\odot$ for its companion

If the companion is a WD, it would be the **fastest rotating** and one of the **most massive** ones, making this system a good candidate Type Ia SN progenitor.

The X-ray luminosity of ~2×10^{32} erg/s is consistent with accretion from the weak wind of HD 49798 onto a WD. An accreting NS should be more luminous.

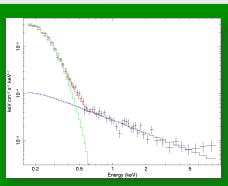
However, the recently discovered spin-up at $dP/dt = -2\times10^{-15}$ s s^{-1} is difficult to explain for a WD, and suggests instead a NS companion.

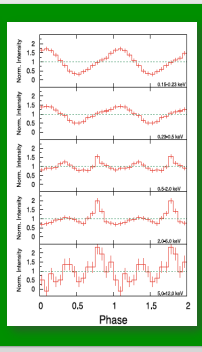
In any case, the properties of this system are different from those of all the known binaries containing WDs or NSs and several puzzles remain in both scenarios.

References

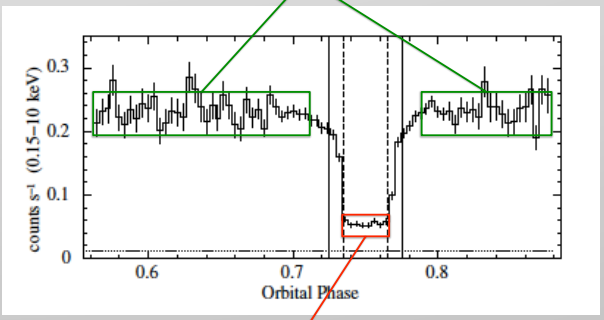
Israel et al. 1997, ApJ 474, L53
Mereghetti et al. 2009,Science 325,1222
Mereghetti et al. 2011, ApJ 737, 51
Mereghetti et al. 2013, A&A 553, A46

OUT OF ECLIPSE





The spectrum is a strongly pulsed, soft blackbody (kT~30 eV) plus a hard power-law tail with a double peaked modulation.
The bolometric X-ray luminosity is $(2+/-0.5)\times10^{32}$ erg/s (for d=650 pc).



DURING ECLIPSE

When the pulsar is eclipsed, emission from the wind of HD 49798 is visible.
The spectrum is thermal.
See also Poster B06

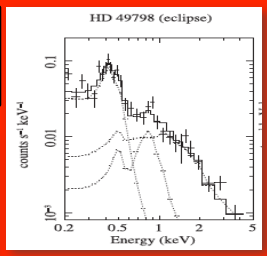
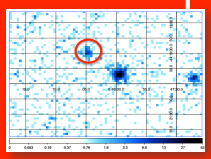


Image of HD49798 during the X-ray eclipse



DISCOVERY OF SPIN-UP AND ITS IMPLICATIONS

A phase-connected timing solution of all the XMM-Newton, Swift/XRT and ROSAT data, spanning from 1992 to 2014, shows a remarkably stable spin-up at a rate of (-2.15+/-0.05) x 10^{-15} s s^{-1}.

The specific angular momentum carried by the accreted matter is insufficient to give such a high spin-up for a WD, unless accretion occurs by Roche-lobe overflow.
However, this requires d>4 kpc (at variance with the optical estimates: d <1 kpc), to reconcile the observed and predicted X-ray luminosity.

Thanks to its ~10^5 smaller momentum of inertia, it is easier to spin-up a NS than a WD. However, a fine tuning between accretion rate and magnetic field strength is required in this case to have a sufficiently large torque without entering the propeller state.
The minimum accretion rate (>2 10^{11} g/s) gives L_X consistent with the observations, but a rather small magnetic field is required for the NS.

A good measurement of the distance based on a better model of the optical/UV data, or with a GAIA parallax, is needed to identify the nature of the compact companion of this peculiar system.

See details in Mereghetti et al. 2016, MNRAS 458, 3253