Massive stars as seen with *eROSITA*

G. Rauw[1], Y. Nazé[1], J. Robrade[2] & J.H.M.M. Schmitt[2]

(1) High-Energy Astrophysics Group, Institut d'Astrophysique et de Géophysique, Université de Liège, Belgium

(2) Universität Hamburg, Hamburger Sternwarte, Germany

Introduction :

X-ray emission from massive stars was initially discovered with the *EINSTEIN* observatory. Many subsequent observations demonstrated that O-type stars follow a scaling relation between their X-ray and bolometric luminosity with $\log(L_X/L_{bol}) \sim -7$ (e.g. the study by Berghöfer et al. 1997, A&A 322, 167 based on the *ROSAT* all-sky survey, see also Fig.1 from Nazé 2009, A&A 506, 1055), whilst no clear relation is found for Wolf-Rayet (WR) or Luminous Blue Variable (LBV) stars. The X-ray emission from massive stars arises most likely inside their powerful stellar winds, but the physical origin of the scaling relation for O-stars remains currently unknown (Owocki & Cohen 1999, ApJ 520, 823). There are some tentative hints that the L_X/L_{bol} relation for O-type stars could depend upon some local parameters (metallicity, age,…, e.g. Nazé 2009). Quantifying the impact of these parameters by studying a large sample of stars in different open clusters could help understanding the origin of the relation. The *eROSITA* all-sky survey will help address this issue as well as many open questions about the X-ray emission of massive stars.

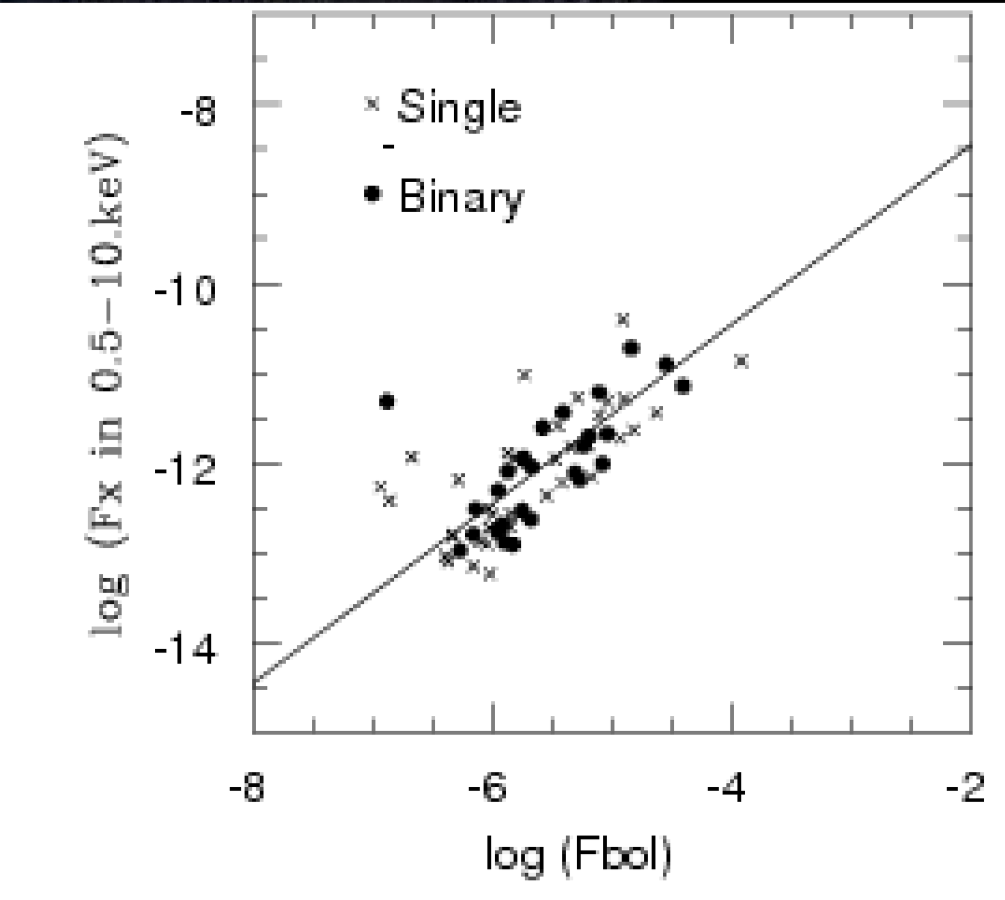


Fig.1: L_X/L_{bol} relation for 133 O-type stars as obtained from the 2XMMi catalogue (Nazé 2009).

Massive stars in the eROSITA all-sky survey

The vast majority of the massive stars of our Galaxy are located in open clusters inside the spiral arms of the Galaxy (hence in the Galactic plane). For sources in the Galactic plane the total exposure time of the *eROSITA* all-sky survey will be about 2 ksec on average (see Fig. 2). Nazé (2009) showed that the average X-ray spectrum of an O-type star can be described by a 2-T thermal plasma: wabs*apec(2T) with kT_1 = 0.24 keV, kT_2 = 2.26 keV and $norm_1/norm_2$ = 10. The absorbing column arises from the sum of the intrinsic wind absorption (0.4×10^{22} cm^{-2}) and the interstellar column. This model was folded through the erosita_iv_7telfov_ff.rsp response matrix to simulate spectra of stars with different interstellar column densities and different X-ray fluxes (corrected for the ISM absorption). The results are shown in Fig. 3. This latter figure shows the contours corresponding to a total number of 40 (red curve), 80 (pink curve) and 160 (blue curve) counts for a total integration time of 2 ksec. On top of these contours, we show the predicted positions of 337 O-type stars from the Galactic O-star Catalogue (GOSC, Maíz-Apellániz et al. 2004, ApJS 151, 103). This figure indicates that the bulk of these O-stars will be observed with a sufficient number of counts to perform CCD spectroscopy and infer accurate spectral parameters and fluxes of a much larger sample of O-type stars than what could be done so far.

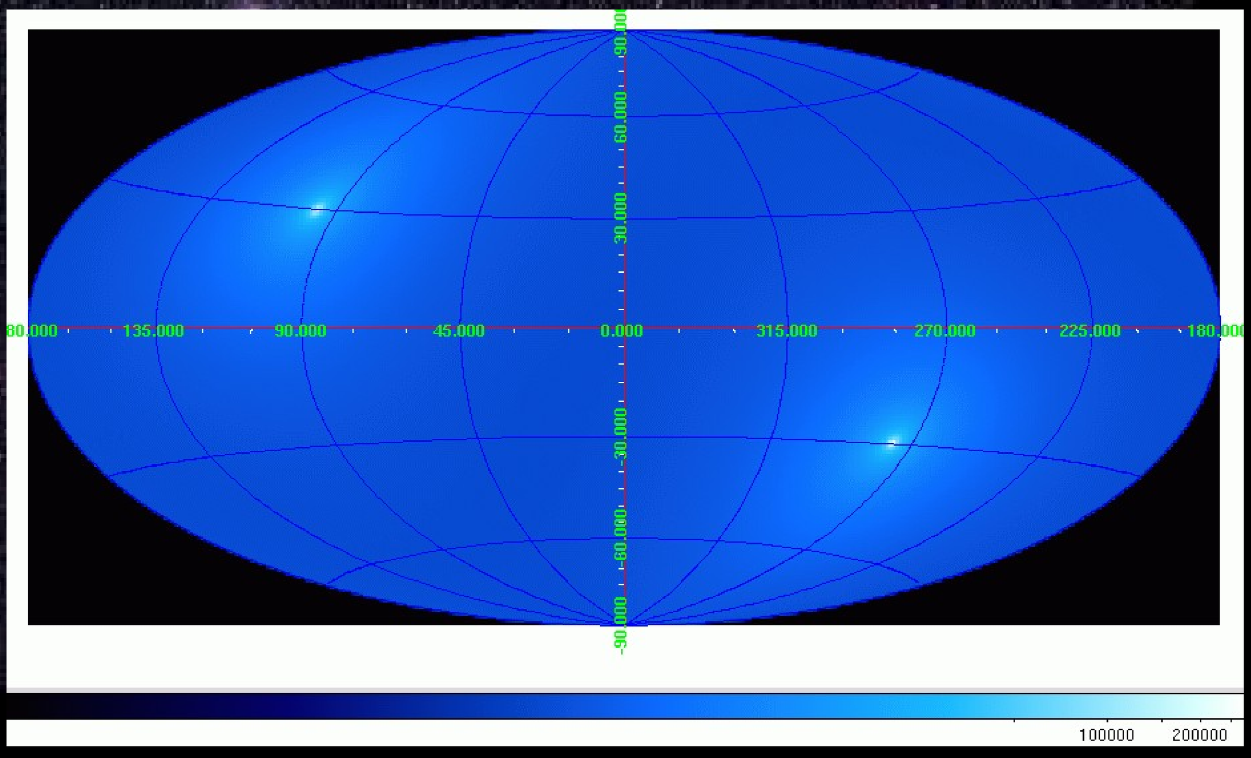


Fig.2: Expected exposure level of the *eROSITA* all-sky survey (galactic coords.).

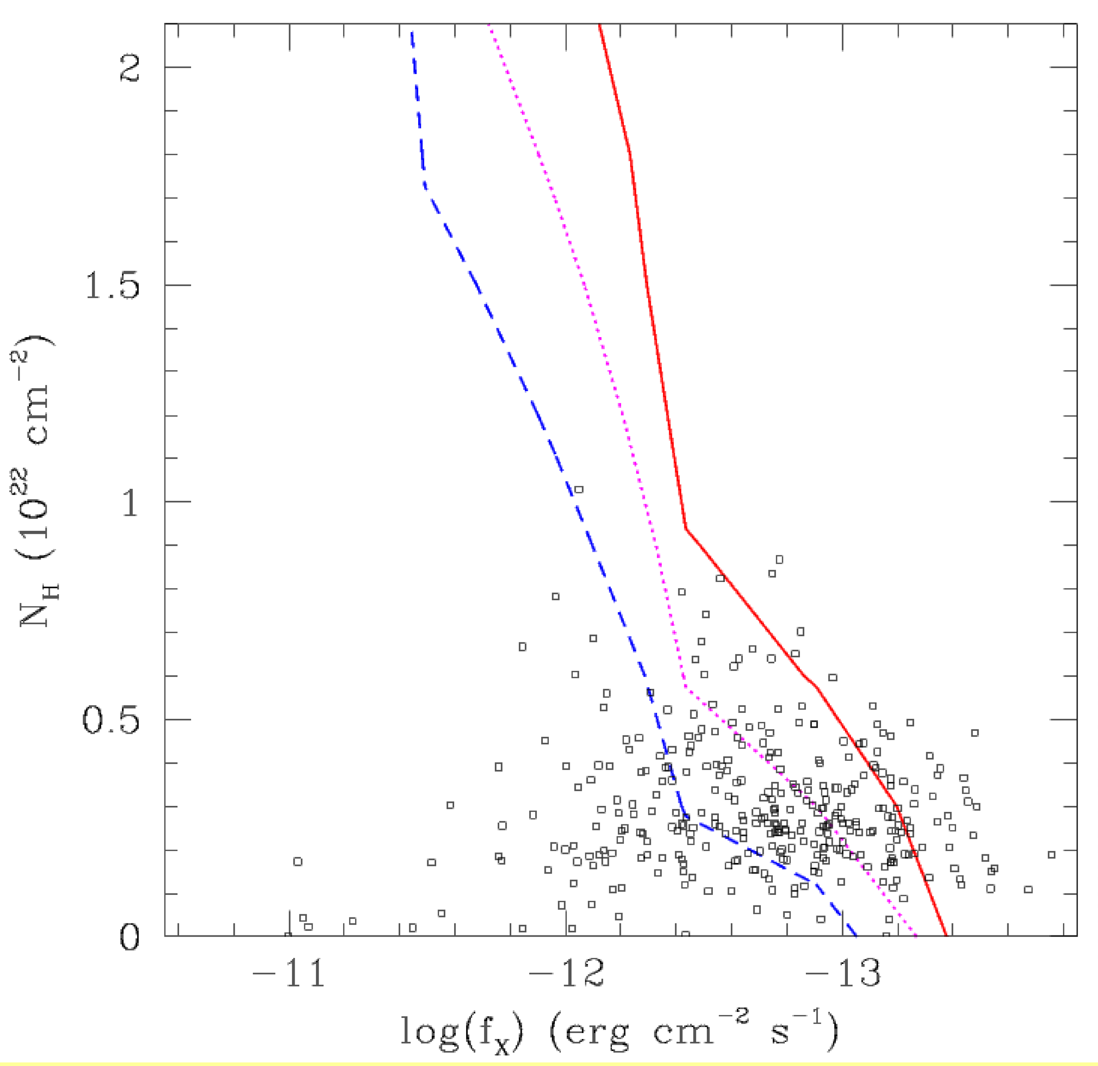


Fig.3: Contours of the expected numbers of counts in the *eROSITA* spectra of O-type stars as a function of ISM corrected X-ray flux and ISM column density (see text box for details).

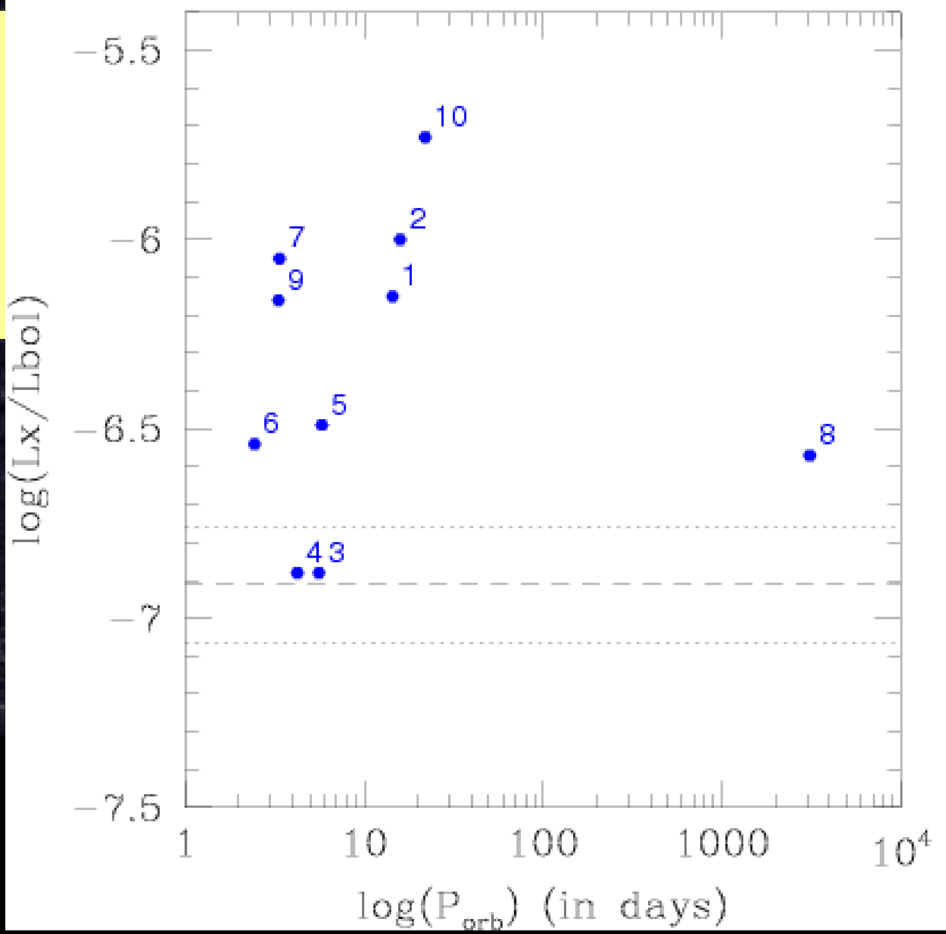
Other classes of massive stars

Beside a detailed investigation of the L_X/L_{bol} relation of O-type stars, *eROSITA* can also help us address a number of other pending questions about other categories of massive stars. Indeed, the *eROSITA* all-sky survey will provide a flux limited survey of B, WR and LBV stars with much deeper sensitivity than e.g. the *ROSAT* survey . The most obvious topics to address are:

- What is the actual incidence of X-ray emission among B-type stars (e.g. Evans et al. 2011, ApJS 194, 13)? Can the X-ray emission arise from unknown low-mass PMS companions and how dark are X-ray dark B-stars?
- What is the level of X-ray emission from WR stars of the different subclasses (e.g. Oskinova et al. 2003, A&A 402, 755, Pollock et al. 1995, IAUS 163, 512)? A sensitive survey will help quantify the role of the absorption of the X-rays by the stellar wind.

In addition, the *eROSITA* survey will allow us to probe the incidence of phenomena such as colliding winds or magnetically confined winds that are expected to enhance the X-ray emission of massive stars. By providing data on a large number of such systems, the survey will allow us to investigate the trends in X-ray (over)luminosity with stellar and magnetic properties (for MCWs) and with stellar and binary parameters (for CWBs). A few trends have been tentatively suggested, but they are based on smaller samples (e.g. for CWBs: Linder et al. 2006, MNRAS 370, 1623, see Fig. 4) and therefore require confirmation.

Fig.4: log(: L_X/L_{bol}) as a function of orbital period for a sample of colliding wind binary systems observed with *XMM-Newton* (from Linder et al. 2006).



Conclusions: The *eROSITA* all-sky survey will open up new, exciting possibilities for understanding the X-ray emission of massive stars of all spectral types. An unprecedented sample of CCD spectra will become available, hence allowing, for the first time, to draw statistically significant conclusions.