On the spectrum and polarization of magnetar flare emission

R. Taverna[1*], R. Turolla[1,2†]

[1]Department of Physics and Astronomy, University of Padova, via Marzolo 8, I-35131 Padova, Italy

[2]Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Surrey, RH5 6NT, UK

Bursts and flares are among the distinctive observational manifestations of magnetars, isolated neutron stars endowed with an ultra-strong magnetic field ($B \approx 10^{14}$–10^{15} G). It is believed that these events arise in a hot electron-positron plasma, injected in the magnetosphere, due to a magnetic field instability, which remains trapped within the closed magnetic field lines [the "trapped-fireball" model, see 1, 2]. We have developed a simple radiative transfer model to simulate magnetar flare emission in the case of a steady trapped fireball. After dividing the fireball surface in a number of plane-parallel slabs, the local spectral and polarization properties are obtained integrating the radiative transfer equations for the two normal modes. We assume that magnetic Thomson scattering is the dominant source of opacity, and neglect contributions from second-order radiative processes, although the presence of double-Compton scattering is accounted for in establishing local thermal equilibrium in the fireball atmospheric layers [3]. The observed spectral and polarization properties as measured by a distant observer are obtained summing the contributions from the patches which are visible for a given viewing geometry by means of a ray-tracing code. The spectra we obtained in the 1–100 keV energy range are thermal and can be described in terms of the superposition of two blackbodies. The blackbody temperature and the ratio of the emitting areas are in broad agreement with the observations available so far [4–6]. The predicted linear polarization degree is in general greater than 80% over the entire energy range. Such a large degree of polarization should be easily detectable by new-generation X-ray polarimeters, like IXPE, XIPE and eXTP, allowing to confirm the model predictions.

References

[1] Thompson C. & Duncan R. C., 1995, *MNRAS*, 275, 255

[2] Thompson C., Duncan R. C., 2001, *ApJ*, 561, 980

[3] Lyubarsky Y. E., 2002, *MNRAS*, 332, 199

[4] Israel G. L. et al., 2008, *ApJ*, 685, 1114

[5] Olive J.-F. et al., 2004, *ApJ*, 616, 1148

[6] Feroci M. et al., 2004, *ApJ*, 612, 408

*E-mail: taverna@pd.infn.it

†E-mail: turolla@pd.infn.it