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Constraining X-ray-Induced Photoevaporation of Protoplanetary Disks Orbiting Low-Mass Stars

Kristina M. Punzi[1], Joel H. Kastner[1], David Rodriguez[2], David A. Principe[3,4], and Laura Vican[5]

[1]Laboratory for Multiwavelength Astrophysics, Rochester Institute of Technology
[2] Universidad de Chile
[3] Núcleo de Astronomía de la Facultad de Ingeniería, Universidad Diego Portales
[4] Millennium Nucleus Protoplanetary Disks
[5] University of California, Los Angeles

Abstract. Low-mass, pre-main sequence stars possess intense high-energy radiation fields as a result of their strong stellar magnetic activity. This stellar UV and X-ray radiation may have a profound impact on the lifetimes of protoplanetary disks. We aim to constrain the X-ray-induced photoevaporation rates of protoplanetary disks orbiting low-mass stars by analyzing serendipitous XMM-Newton and Chandra X-ray observations of candidate nearby (D < 100 pc), young (age < 100 Myr) M stars identified in the GALEX Nearby Young-Star Survey (GALNYSS).

Keywords. stars: low-mass, pre-main sequence; techniques: imaging spectroscopy; X-rays: stars

1. Introduction

Low-mass (M-type) stars represent some of the best targets for the discovery of potentially habitable exoplanets due to their low luminosities and the location of their habitable zones. Presently, only a small number of planets have been detected around M stars, with terrestrial planets being common and giant planets being rare, although these results may be affected by a selection bias (e.g., Mulders *et al.* 2015, Howard *et al.* 2012). This trend may be a consequence of the intense high-energy radiation fields of low-mass, pre-main sequence stars. A great deal of mass in protoplanetary disks is lost from the surface of the disk due to heating (photoevaporation) from high-energy radiation from the central star. The X-rays from young stars drive disk dissipation and chemistry, influencing the timescale and conditions for exoplanet formation. According to Owen *et al.* (2012), stellar X-ray luminosity alone sets the photoevaporation rate. However, Gorti *et al.* (2015) demonstrate that X-ray spectral hardness is also important. Hence, it is necessary to fully characterize the X-ray radiation fields incident on protoplanetary disks.

2. Serendipitously Detected X-ray Counterparts

To constrain the X-ray-induced photoevaporation rates of protoplanetary disks orbiting low-mass stars, we can examine stars from the GALEX Nearby Young-Star Survey (GALNYSS; Rodriguez *et al.* 2013) that have been serendipitously observed by either XMM-Newton or Chandra. GALNYSS combines ultraviolet (GALEX) and near-IR (WISE and 2MASS) photometry with kinematics to identify candidate nearby (D < 100 pc), young (age < 100 Myr), low-mass (M-type) stars. This survey has identified >2000 candidates, with most of the stars having spectral types in the range M3-M4.

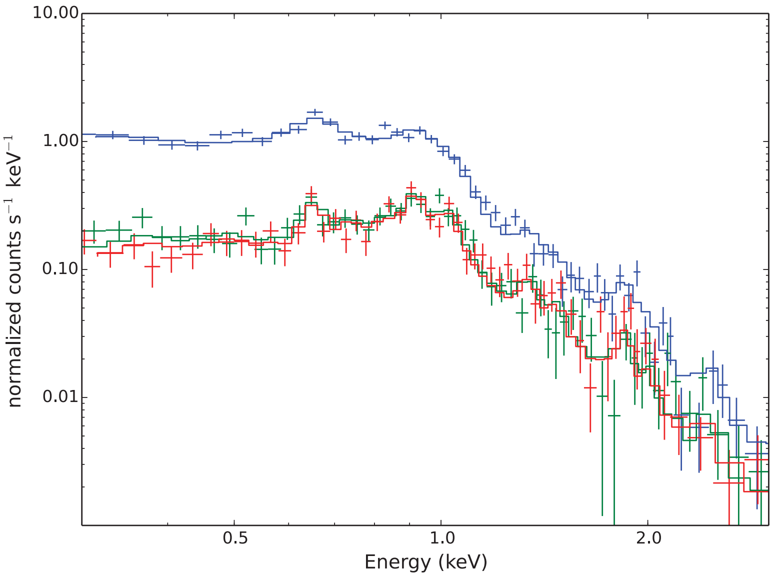

Figure 1. XMM-Newton EPIC extracted spectra (crosses) of J061313.30-274205.6 (spectral type M3, β Pictoris Moving Group candidate – 99.24% likelihood) for pn (blue) and MOS (red and green) detectors. Overplotted are the best-fit models (histograms). Our model predicts plasma temperatures of ~ 3.6 and ~ 12 MK and an X-ray luminosity of 1.2×10^{29} erg s^{-1} at a distance of ~ 25 pc.

The XMM-Newton data for GALNYSS candidates are being reprocessed and analysed using the Scientific Analysis System following standard procedures†. Spectra are extracted from the EPIC detectors using circular regions centered on the 2MASS/WISE positions of the objects. Spectral modelling is performed with XSPEC. An example of the extracted spectra and resulting model fit is displayed in Figure 1. Our models consist of X-ray spectra that result from optically thin plasmas in collisional ionization equilibrium (vapec model in XSPEC‡). These emission spectra were combined with photoelectric absorption by using the XSPEC model wabs.

3. Conclusions and Future Work

Our preliminary results demonstrate that serendipitous XMM-Newton observations of GALNYSS stars are capable of producing useful constraints on the stellar X-ray temperature and luminosity and hence, on photoevaporation due to X-ray irradiation. These early results suggest that X-ray photoevaporation may not account for complete disk dispersal at ages $\sim$ 8-20 Myr. For the entire sample of serendipitously observed GALNYSS stars, we will determine X-ray temperatures and luminosities, the potential correlation between M star L_X and residual disk mass, and the mass dependence of L_X/L_{bol}.

References

Gorti, U., Hollenbach, D., & Dullemond, C. P., 2015, *ApJ*, 804, 29.
Howard, A. W., Marcy. G. W. Bryson, S. T., *et al.* 2012, *ApJS*, 201, 15.
Mulders, G. D., Pascucci, I., & Apai, D. 2015, *ApJ*, 798, 112.
Owen, J. E., Clarke, C., J., & Ercolano, B., 2012, *MNRAS*, 422, 1880.
Rodriguez, D. R., Zuckerman, B., Kastner, J. H., *et al.*, 2013, *ApJ*, 744, 101.

† See the SAS documentation at http://xmm.esac.esa.int/sas/current/documentation/threads.
‡ See the XSPEC documentation at https://heasarc.gsfc.nasa.gov/xanadu/xspec/manual/Models.html for a description of the models.

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