AN ARCHIVAL STUDY OF HST OBSERVATIONS OF HER X–1/HZ HER

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1. Introduction

Her X–1 is an X-ray pulsar with a rotation period of 1.24 s and a binary period of 1.7 d (Tananbaum et al. 1972). The 1.7 d variations in optical and ultraviolet flux are attributed to X-ray heating of the companion star and disk (e.g. Howarth & Wilson 1983, hereafter HW83). The system displays a 35 d period, attributed to the effects of a tilted, precessing, accretion disk. Optical and ultraviolet flux variations continue *unchanged* throughout. This work is motivated by the following reasons:

- The observed IUE spectra have significantly flatter slopes than those predicted by previous models (e.g. HW83).
- The observed strength of the Balmer jump is anomalously low compared to that expected for a normal B star (Anderson et al. 1994).
- HST observations obtained by Anderson et al. (1994) in order to study emission lines have yielded high quality spectra of the *continuum* emission from HZ Her, enabling for the first time detailed model fitting efforts.

2. Model

- Adopt the system geometry of HW83 and X-ray heating code described in Vrtilek et al. (1990, 1991).
- Assume both disk and star have an albedo of 50%.
- Estimate $E(B-V) < 0.05$ from the lack of a 2200 Å absorption feature.
- Use $L_X = 0.5GM\dot{M}/r_1$, where r_1 is the radius of the neutron star.
- Calculate the temperature at star and disk surfaces due to X-ray heating. Use IUE and Kitt Peak stellar fluxes (referred to as *star-type spectra*) for that temperature to determine UV/optical continuum flux (HW83 used model stellar atmospheres).

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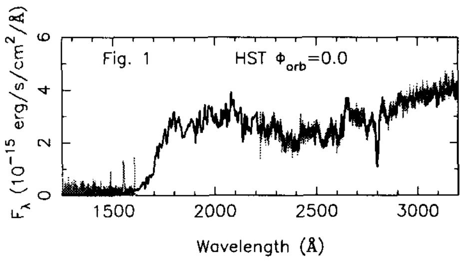

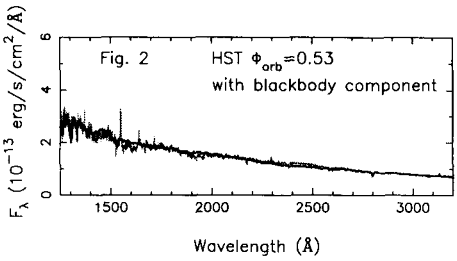

- Include blackbody component. Introduce two critical temperatures: T_{sc} and T_{dc}. For a given area element in the disk and star, if the temperatures T_d and T_s are higher than T_{dc} or T_{sc}, compute the flux using a blackbody, otherwise use *star-type* spectrum.
- Free parameters are $\dot{M}$, T_{dc} and T_{sc}, ϕ_{orb}, ϕ_{35}. Fixed parameters are q, β, θ_d, α_d, $\Delta\psi$, i, a, d, r_1 and r_2 (a detailed description of the model can be seen in Cheng, Vrtilek & Raymond 1995).

3. Results

- At $\phi_{orb} \sim 0.0$, we obtain the average temperature of the unheated star surface $T_{s0} = 8\,100 \pm 240$ K (Fig. 1).
- At $\phi_{orb} \sim 0.5$, we obtain $T_{dc} \sim 10\,000$ K, $T_{sc} \sim 18\,900$ K, and $\dot{M} = (6.5 \pm 0.9)\,10^{-9}\,M_\odot\,yr^{-1}$ (Fig. 2).
- Balmer Jump: see Table 1.

TABLE 1. Comparison of the Balmer Jump

ϕ_{orb}	Observed BJ	Model BJ
0.0	3.0	2.8
0.53	1.3	1.8 (no blackbody)
0.53	1.3	1.4 (with blackbody)

References

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