Loop Modeling of ROSAT/PSPC Spectra of Hyades and Field F-Type Stars

A. Maggio, G. Peres

Istituto e Osservatorio Astronomico "G.S. Vaiana", Palazzo dei Normanni, I-90134 Palermo, Italy

J.P. Pye, S.T. Hodgkin, J.E. Morley

Department of Physics and Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, England, U.K.

1. Introduction

The complex thermal structure of a magnetically-confined corona can be described by models of coronal loops, based on firm theoretical grounds and already tested with success in the interpretation of observations of the solar corona. Some aspects of the analysis of stellar X-ray spectra with loop models have been recently revised in Ciaravella et al. 1995, and Maggio & Peres 1995 (both in press on A&A). Here we report on the fitting of high signal-to-noise ROSAT/PSPC spectra of F-type stars with detailed coronal loop models, as part of a program for the systematic analysis of X-ray observations of late-type stars.

2. Observations and Method of Analysis

We have selected five Hyades members (VB 32, 34, 37, 40, 57) and three field stars (Procyon, η Lep, and τ Eri). We have used an upgraded version of the hydrostatic coronal loop model of Serio et al. (1981, ApJ 243, 288), along with the *Analysis System for Astrophysical Plasmas* (Maggio et al. (1994, CPC 81, 105) for the synthesis of the predicted loop spectrum (see also Ciaravella et al., this volume). We have derived best-fit models and statistical confidence regions in the model parameter space, assuming that the X-ray emission originates predominantly from one class of loops, all with identical characteristics. Sample X-ray spectra and the corresponding confidence regions are shown in Fig. 1.

3. Results and Discussion

We have found acceptable good fits for about half of the spectra we have analyzed. The X-ray emission of the relatively active Hyades members – most of them being spectroscopic binaries – may originate from very large coronal loops (L > R_*) with plasma base pressure in the range 1 - 4 dyne cm^{-2}, covering almost completely the stellar surface. Their PSPC spectra cannot be fitted with loop models of small, very-high pressure coronal structures, as instead suggested by previous analysis of *Einstein* IPC spectra (Stern et al. 1986, ApJ, 305, 417).

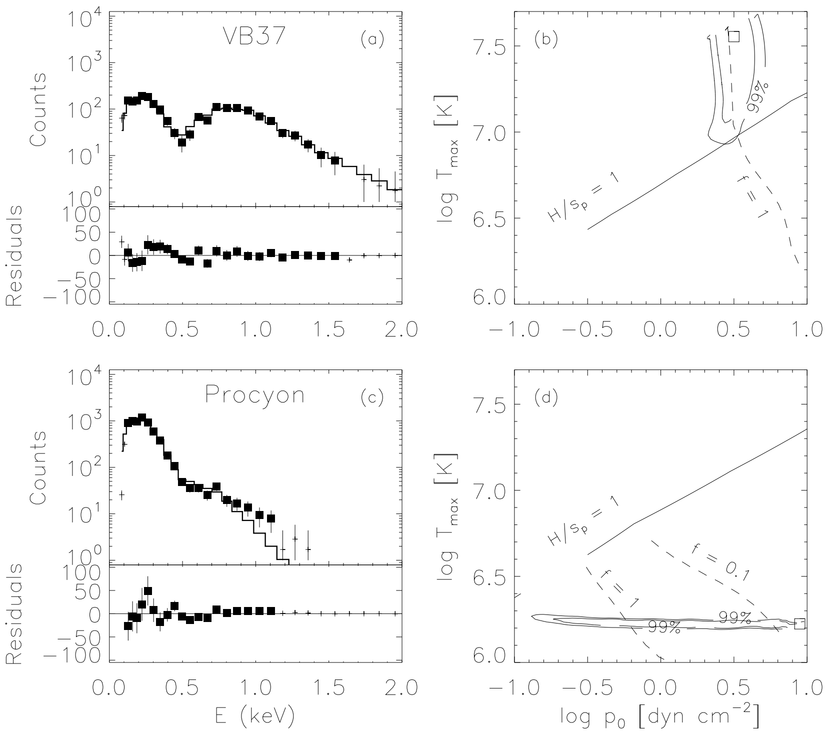

Figure 1. Loop modeling of VB 37 (F4V) and Procyon (F5IV-V). In (a) and (c), ROSAT/PSPC spectra with best-fit loop model spectra and residuals. The energy bins used in the fitting are indicated by the filled squares. We obtained a reduced $\chi^2 = 0.9$ with 21 d.o.f. for VB37, and 1.4 with 16 d.o.f. for Procyon. In (b) and (d), the corresponding 90% and 99% confidence regions in the plane of plasma maximum temperature vs. loop base pressure. The solid lines indicate the locus where the loop height is equal to one pressure scale height. The dashed lines indicate loci of constant surface filling factor.

Instead, the corona of Procyon, an archetype of the low activity F stars, can be described by short loops, well below one pressure scale height, and covering only few percent of the surface. This description is compatible with independent estimates of the continuous emission measure distribution vs. temperature and of the coronal plasma density derived from the analysis of EUVE spectra (Schmitt et al. 1994, Science 265, 1420; Drake et al. 1995, ApJ 443, 393).

We stress that the description assuming a single class of loops may not be univocal: alternative interpretations of the observed X-ray spectra are possible, in some case, with two-component loop models. We are currently investigating also this class of solutions.