$gamma$ Cassiopeiae: an X-ray Be star with personality

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An exciting unsolved problem in the study of high energy processes of early type stars concerns the physical mechanism for producing X-rays near the Be star $gamma$ Cassiopeiae. By now we know that this source and several ``$gamma$ Cas analogs'' exhibit an unusual hard thermal X-ray spectrum, compared both to normal massive stars and the non-thermal emission of known Be/X-ray binaries. Also, its light curve is variable on almost all conceivable timescales. In this study we reanalyze a high dispersion spectrum obtained by {it Chandra} in 2001 and combine it with the analysis of a new (2004) spectrum and light curve obtained by XMM-{it Newton.} We find that both spectra can be fit well with 3--4 optically thin, thermal components consisting of a hot component having a temperature kT$_Q$ sim 12--14,keV, {it perhaps} one with a value of sim 2.4,keV, and two with well defined values near 0.6,keV and 0.11,keV. We argue that these components arise in discrete (almost monothermal) plasmas. Moreover, they cannot be produced within an integral gas structure or by the cooling of a dominant hot process. Consistent with earlier findings, we also find that the Fe abundance arising from K-shell ions is significantly subsolar and less than the Fe abundance from L-shell ions. We also find novel properties not present in the earlier {it Chandra} spectrum, including a dramatic decrease in the local photoelectric absorption of soft X-rays, a decrease in the strength of the Fe and possibly of the Si K fluorescence features, underpredicted lines in two ions each of Ne and N (suggesting abundances that are sim 1.5--3$times$ and sim 4$times$ solar, respectively), and broadening of the strong Ne,X,Ly$alpha$ and O,VIII,Ly$alpha$ lines. In addition, we note certain traits in the $gamma$ Cas spectrum that are different from those of the fairly well studied analog hd - in this sense the stars have different ``personalities.'' In particular, for $gamma$ Cas the hot X-ray component remains nearly constant in temperature, and the photoelectric absorption of the X-ray plasmas can change dramatically. As found by previous investigators of $gamma$ Cas, changes in flux, whether occurring slowly or in rapidly evolving flares, are only seldomly accompanied by variations in hardness. Moreover, the light curve can show a ``periodicity'' that is due to the presence of flux minima that recur semiregularly over a few hours, and which can appear again at different epochs.

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