OPTICAL, UV AND X-RAY OBSERVATIONS OF THE SYMBIOTIC STAR AG DRACONIS DURING QUIESCENCE AND THE 1994/1995 OUTBURST

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ABSTRACT. Optical, UV and X-ray observations of the well known symbiotic star AG Draconis during quiescence and the active phase 1994/1995 are presented. The intensity in the UV region is well correlated with the optical activity. The observed X/ray flux dropped down by a factor of about 100 during the outburst maximum.

Key words: Symbiotic stars, X-ray sources, AG Dra

Introduction

AG Draconis is one of the most observed symbiotic stars. These stars are binary systems consisting of a cool late (M-) type primary component and a hot compact object (white dwarf, subdwarf). Because of mass loss of the primary both components are embedded in a common nebulous envelope.

AG Dra plays an outstanding role inside the group of the symbiotic stars because of its high galactic latitude ($b^{\rm II} = +41°$), its large radial velocity ($v_{rad} = -148$ km/s) and its early spectral type (K). This star is probably a metal poor symbiotic binary in the galactic halo. The historical light curve is characterized by active and quiescent phases. The active phases show outbursts of 1-2 mag in B and V followed by one or more secondary maxima. Between the active phases AG Dra is spending long periods (years to decades) at minimum light with small (0.1 mag) semiregular variations in B and V with periods of 300-400 days.

In U however regular variations with amplitudes of 1 mag and a period of 554 days are visible. This period is associated with the orbital motion of the system.

The optical spectrum of AG Dra is typical of a symbiotic star, with a probably stable cool component which dominates in the yellow region, and a largely variable nebular component with a strong blue/UV continuum and a rich emission line spectrum.

The UV continuum and line flux varies strongly with the star's activity (factor 10 in the continuum and factor 2-5 in the line flux during the 1980-83 active phase).

First X-ray observations of AG Dra during the quiescent phase with the EINSTEIN satellite revealed a soft X-ray spectrum. EXOSAT observations during the small active phase 1985/86 showed a large X-ray fading with respect to quiescence.

Recent observations

In June/July 1994 AG Dra went into a major outburst, after which it gradually declined to the quiescent level in November 1994. Like 1981/82 and 1985/86 the star underwent a secondary outburst in July 1995. In addition to the optical observations a coordinated ROSAT/IUE campaign was carried out to study the star as in the optical as in the short wavelength ranges.

IUE Observations

AG Dra was observed by IUE as a Target of Opportunity starting on June 29, 1994. The observations have continued until February 1996, covering the 1994 and 1995 outburst and the quiescent phase between them and the return to quiescence.

ROSAT Observations

AG Dra was scanned during the All-Sky-Survey over a time span of 10 days. The total observation time adds up to 2.0 ksec.

Several pointed observations with spectral resolution on AG Dra have been performed in 1992 and 1993 with the ROSAT PSPC.

When AG Dra was reported to go into outburst it has been proposed for a Target of Opportunity Ob-

servation. Because of technical problems AG Dra has been observed only since Aug. 28, 1994, about 4 weeks after the optical maximum with HRI.

The X-ray light curve of AG Dra

The X-ray intensity has been more or less constant between 1990 and May 1993 before the optical outburst. During the optical outbursts the observed X-ray flux dropped down substantially. The observed maximum amplitude of the intensity decrease is nearly a factor of 100. Between the outburst maxima the X-ray intensity nearly reached the pre–outburst level.

Results

From the optical, UV and X-ray observations the following properties of the AG Dra system were determined:

The X-ray spectrum in quiescence is very soft, with a blackbody temperature of about 175 000 K.

The quiescent bolometric luminosity suggests stable hydrogen burning in quiescence.

The monitoring at X-ray and UV wavelengths did not yield any hints for a predicted eclipse during the U-light minima. During the optical outburst in 1994 th UV continuum increased by a factor of 10, the UV line intensity by a factor of 2 and the X-ray intensity dropped by at least a factor of 100. There is no substantial time lag between the variations in the different energy bands.

There is no hint for an increase of the absorbing column during one X-ray observation with spectral resolution performed during the decline of the optical outburst in 1994. Instead, a temperature decrease is consistent with the X-ray data and also supported by the IUE spectral results.

Modeling the X-ray intensity drop by a slowly expanding white dwarf with concordant cooling, we find that the necessary excess accretion rate is only 27% of the quiescent one. Accordingly, the white dwarf expands to approximately its double size within the about three months rise of the optical outburst. The cooling is moderate: the temperature decreases by only 35%.

AG Dra could either be a symbiotic nova with a turn on before 1855, or the first example of the wide binary supersoft source class.

References

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