Astron. Astrophys. 154, 377–378 (1986)

ASTRONOMY AND ASTROPHYSICS

Research Note

Radio emission of cataclysmic variable stars

E. Fürst [1], A. Benz [2], W. Hirth [3], A. Kiplinger [4], and M. Geffert [5]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-5300 Bonn 1, Federal Republic of Germany
[2] Gruppe für Radioastronomie, Institut für Astronomie ETHZ, ETH-Zentrum, CH-8092 Zürich, Switzerland
[3] Radioastronomisches Institut der Universität, Auf dem Hügel 71, D-5300 Bonn 1, Federdal Republic of Germany
[4] Laboratory for Astronomy and Solar Physics, Goddard Space Flight Center and Applied Research Corporation, Landover, Maryland, USA
[5] Astronomisches Institut der Universität, Auf dem Hügel 71, D-5300 Bonn 1, Federal Republic of Germany

Received January 28, accepted August 9, 1985

Summary. Eight cataclysmic variable stars were observed at 6 cm wavelength using the Very Large Array (VLA). The objects were: CN-Ori, SS-Aur, YZ-Cnc, SU-Uma, Z-Cam, V603-Aq1, EM-Cyg, and RZ-Sge. Most of these objects were in optical high stage, but none were detected beyond flux limits between 0.1 and 0.3 mJy.

Key words: stars: cataclysmic variables – radio continuum

1. Introduction

Recurrent brightness variations of cataclysmic variable stars are normally explained in terms of time-dependent disk accretion in close binary systems. These objects may be radio emitters for several reasons. UV-observations suggest winds from these objects, which may form a large region of thermal radio radiation. Cataclysmic variables are thought to have magnetic fields, which may give rise to particle acceleration, if disturbed during outbursts. In this case nonthermal radio emission can be expected.

There have been several attempts to detect radio emission from cataclysmic variable stars. Chanmugan and Dulk (1982) reported a radio flux of 0.67 mJy of AM-Her, classified as magnetic variable (subtype of cataclysmic variables), possibly produced by gyrosynchrotron emission from electrons in the strong magnetic field of this object. Cordova et al. (1983) reported observations of six objects of the dwarf nova subtype of cataclysmic variable stars with a flux density sensitivity limit between 0.1 and 0.44 mJy. None of these stars have shown radio emission beyond these limits. The authors conclude that the strong magnetic field of AM-Her may play the essential role and that the nature of the AM-Her system (Chanmugan and Dulk, 1983) could make this object unique among the class of cataclysmic variables.

However, none of the objects observed by Cordova et al. (1983) were in or close to the optical high stage. One might expect enhanced radio emission during outbursts of cataclysmic variables. Benz et al. (1984) reported radio emission of the dwarf nova SU-Uma correlated with its optical phase. In its optical high stage they observed a peak flux of 1.3 mJy, while in low stage the flux was less than the detection limit of 0.4 mJy. These observations were done with the 100 m-telescope in Effelsberg, i.e. with relatively low angular resolution. Although the time variability contradicts confusion from background sources, this result needs confirmation.

The VLA was used for new observations of cataclysmic variables including SU-Uma, where the objects were selected according AAVSO reports (Mattei, 1983). Only objects were observed, which were in or close to high optical stage. In one case (SS-Aur) it turned out later that the observation was made between two faint optical outbursts. The optical positions of the objects were taken from POSS prints (Kiplinger, 1984). For three stars (SU-Uma, Z-Cam, and EM-Cyg) new optical positions were obtained from plates of the double refractor of the Hoher List observatory using the Zeiss Ascorecord instrument. A detailed description of this method is given by Bruch et al. (1984).

2. Observations

The VLA observations were made in December 1983 at 4885 MHz with a bandwidth of 50 MHz. The VLA operated in A/B hybrid configuration, some antennas were moved during the observational period. The half maximum field of view and the spatial resolution were about 3′ and 1″ respectively. Observations on source of 20 minutes alternated with runs of 5 minutes on calibration sources. The main calibrator source was 3C286 (7.41 Jy at 4885 MHz). Eight objects were searched for radio emission, none were detected at flux density limits between 0.1 and 0.3 mJy. Some relevant data are summarized in Table 1.

3. Conclusions

The new observations show that radio emission of cataclysmic variable stars at a level of 0.1 mJy is rare and yet confirmed only for AM-Her stars. The absence of radio emission of the newly observed objects puts an upper limit to the mass loss rate of $10^{-8} M_{\odot}$ yr according to the formula of Wright and Barlow (1975), adopting a distance of order 200 pc and a terminal velocity of $\approx 200\,\mathrm{km\,s^{-1}}$. Concerning gyrosynchrotron emission, the production of relativistic electrons even during the optical outbursts and/or the magnetic field is too low to provide a detectable radio flux. There is some conflict between the observations reported by Benz et al. (1983) and the new results. This cannot be explained convincingly at the moment, because only these two measurements are available. The positive observations at Effelsberg were made in the declining phase of outbursts, 1–2 days after the

Send offprint requests to: E. Fürst

Table 1. Objects searched for radio emission. dN = dwarf Nova; max.: $\Delta m \geqq 0.5\ \Delta m$ (max)

Source name	Position R.A. (1950) h	m	s	Dec. (1950) °	′	″	Type	Upper limit of flux density 6cm (mJy)	Observation date/time (UT)	Exposure time (min)	Optical phase
CN−Ori	18	46	21.42	00	31	34.8[a]	dN Z−Cam	0.3	9. 12. 1983 05:22−06:26	57	Decline
SS−Aur	06	09	35.57	47	45	13.8[a]	dN U−Gem	0.1	22. 12. 1983 03:26−07:38	114	Between two faint outburst
YZ−Cnc	08	07	52.71	28	17	31.0[a]	dN SU−Uma	0.1	22. 12. 1983 06:11−11:54	202	Max. superoutburst
SU−Uma	08	08	05.45	62	45	22.8[a]	dN	0.11	9. 12. 1983	88	Max.
	08	08	05.52	62	45	22.2[b]	SU−Uma		07:57−12:21		
Z−Cam	08	19	39.64	73	16	24.7[a]	dN	0.1	9. 12. 1983	131	Max.
	08	19	39.71	73	16	23.3[b]	Z−Cam		06:41−12:45		
V603Aql	18	46	21.42	00	31	34.8[a]	Classical nova	0.13	23. 12. 1983 18:01−21:34	159	–
EM−Cyg	19	36	42.13	30	23	33.5[d]	dN	0.12	16. 12. 1983	105	Max.
	19	36	42.08	30	23	33.9[b]	U−Gem		23:52−01:55		
RZ−Sge	20	01	02.8	16	54	20[c]	dN SU−Uma	0.3	10. 12. 1983 00:20−01:24	58	Max.

[a] Positions from Kiplinger (1984);
[b] Newly estimated positions; SU-Uma (epoch 1981.17), Z-Cam (epoch 1981.14), EM-Cyg (epoch 1984.50);
[c] Position from POSS-prints at VLA

maximum, while the VLA observation was during the peak optical phase. One may wonder, if there is any reason that radio emission becomes observable only in a later phase of outbursts. A possible explanation would be a small-scale nonthermal radio source close to the white dwarf of the system. In this case the peak mass flow during the outburst may lead to a large bremsstrahlung optical depth, which hinders the escape of the radio emission. One or two days after the peak optical emission the mass flow has declined and the radio emission may become observable. To give a reliable answer to this question sensitive observations covering a whole outburst are necessary.

Acknowledgements. The Very Large Array is part of the National Radio Astronomy Observatory, which is operated by Associated Universities, Inc., under contract with the U.S. National Science Foundation. We thank the VLA staff for excellent support during observation and analysis, in particular E. Fomalont and P.C. Crane. We also gratefully acknowledge the optical AAVSO observational data sent to us by the director Janet A. Mattei.

Partial financial support and travel grants were provided by the Swiss Society for Astrophysics and Astronomy (A.O.B.), and NASA grant NAS5-28407 (A.L.K).

References

Benz, A.O., Fürst, E., Kiplinger, A.L.: 1983, *Nature* **302,** 45
Bruch, A., Fischer, F.-J., Wilmsen, U.: 1984, *Mitt. Astron. Ges.* **62,** 283
Chanmugan, G., Dulk, G.A.: 1982, *Astrophys. J.* **255,** L107
Chanmugan, G., Dulk, G.A.: 1983, *IAU Colloq.* No. **72,** eds. M. Livio, G. Shaviv, p. 223
Cordova, F.A., Mason, K.O., Hjellming, R.M.: 1983, *Publ. Astron. Soc. Pacific* **95,** 69
Kiplinger, A.L.: 1984, *Inf. Bull. Variable Stars* No. **2492,** 2
Mattei, J.: 1983 (private communication)
Wright, A.E., Barlow, M.J.: 1975, *Monthly Notices Roy. Astron. Soc.* **170,** 41