A THEORETICAL LIGHT-CURVE MODEL FOR THE RECURRENT NOVA V394 CORONAE AUSTRALIS

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ABSTRACT

A theoretical light curve for the 1987 outburst of V394 Coronae Australis (V394 CrA) is modeled to obtain various physical parameters of this recurrent nova. We then apply the same set of parameters to a quiescent phase and confirm that these parameters give a unified picture of the binary. Our V394 CrA model consists of a very massive white dwarf (WD), with an accretion disk (ACDK) having a flaring-up rim, and a lobe-filling, slightly evolved, main-sequence star (MS). The model includes irradiation effects of the MS and the ACDK by the WD. The early visual light curve (t ~ 1–10 days after the optical maximum) is well reproduced by a thermonuclear runaway model on a very massive WD close to the Chandrasekhar limit $1.37^\pm0.01 M_\odot$. The ensuing plateau phase (t ~ 10–30 days) is also reproduced by the combination of a slightly irradiated MS and a fully irradiated flaring-up disk with a radius ~1.4 times the Roche lobe size. The best-fit parameters are the WD mass $M_\odot$, the companion mass ~1.5 $M_\odot$ (0.8–2.0 $M_\odot$ is acceptable), the inclination angle of the orbit $i$ ~ 65°–68°, and the flaring-up rim ~0.30 times the disk radius. The envelope mass at the optical peak is estimated to be $6 \times 10^{-6}$ $M_\odot$, which indicates an average mass accretion rate of $1.5 \times 10^{-7}$ $M_\odot$ yr$^{-1}$ during the quiescent phase between the 1949 and 1987 outbursts. In the quiescent phase, we properly include the accretion luminosity of the WD and the viscous luminosity of the ACDK as well as the irradiation effects of the ACDK and MS by the WD. The observed light curve can be reproduced with a disk size of 0.7 times the Roche lobe size and a rather slim thickness of 0.05 times the accretion disk size at the rim. About 0.5 mag sinusoidal variation of the light curve requires a mass accretion rate higher than $1.0 \times 10^{-6}$ $M_\odot$ yr$^{-1}$, which is consistent with the above estimation from the 1987 outburst. These newly obtained quantities are exactly the same as those predicted in a new progenitor model of Type Ia supernovae.

Subject headings: accretion, accretion disks — binaries: close — novae, cataclysmic variables — stars: individual (V394 Coronae Australis)

1. INTRODUCTION

Type Ia supernovae (SNe Ia) are one of the most luminous explosive events of stars. Recently, SNe Ia have been used as good distance indicators that provide a promising tool for determining cosmological parameters because of their almost uniform maximum luminosities; see Riess et al. (1998) and Perlmutter et al. (1999). Both groups derived the maximum luminosities ($L_{\text{max}}$) of SNe Ia completely empirically from the shape of the light curve (LCS) of nearby SNe Ia and assumed that the same $L_{\text{max}}$-LCS relation holds for high-redshift SNe Ia. To be sure of any systematic biases, the physics of SNe Ia must be understood completely. By far, one of the greatest problems facing SN Ia theorists is the lack of a real progenitor (e.g., Livio 2000 for a recent review). Finding a reliable progenitor is urgently required in SN Ia research. Recurrent novae are probably the best candidates for this target (e.g., Starrfield, Sparks, & Truran 1985; Hachisu, Kato, & Nomoto 1999a; Hachisu et al. 1999b).

Recently, the recurrent nova U Sco underwent the sixth recorded outburst on 1999 February 25. For the first time, a complete light curve has been obtained from the rising phase to the final fading phase toward quiescence through the midplateau phase (e.g., Matsumoto, Kato, & Hachisu 2000). Constructing a theoretical light curve of the outburst, Hachisu et al. (2000a) have estimated various physical parameters of U Sco: (1) The early linear phase of the outburst ($t$ ~ 1–10 days after the optical maximum) is well reproduced by a thermonuclear runaway model on a 1.37 $\pm$ 0.01 $M_\odot$ white dwarf (WD). (2) The envelope mass at the optical maximum is estimated to be $3 \times 10^{-6}$ $M_\odot$, which results in the mass transfer rate of $2.5 \times 10^{-7}$ $M_\odot$ yr$^{-1}$ during the quiescent phase between the 1987 and 1999 outbursts. (3) About 60% of the envelope mass has been blown off in the outburst wind, but the residual 40% (~$2 \times 10^{-6}$ $M_\odot$) of the envelope mass has been left and accumulated on the white dwarf. Therefore, the net mass increasing rate of the white dwarf is $1.0 \times 10^{-7}$ $M_\odot$ yr$^{-1}$, which meets the condition for SN Ia explosions of carbon-oxygen cores (Nomoto & Kondo 1991). Thus, Hachisu et al. (2000a, 2000b) have concluded that the white dwarf mass in U Sco will reach the critical mass ($M_{\text{crit}} = 1.378$ $M_\odot$, taken from Nomoto, Thielemann, & Yokoi 1984) in quite the near future and explode as an SN Ia. Therefore, we regard that U Sco is a very strong candidate for the immediate progenitor of SNe Ia.

It has been suggested that the recurrent nova V394 CrA is a twin system of U Sco because of its almost same decline rate of the early light curve and spectrum feature during the outburst (e.g., Sekiguchi et al. 1989). It is very likely that the physical parameters obtained for U Sco are common to V394 CrA. In this paper, we derive various physical quantities of V394 CrA, both during the 1987 outburst and in quiescence, by constructing the same theoretical light-curve...
models as for U Sco and examine whether or not V394 CrA is an immediate progenitor of SNe Ia. In § 2, we briefly describe our light-curve model during the outburst and present the fitting results for the 1987 outburst of V394 CrA. In § 3, based on the physical parameters obtained in § 2, we construct theoretical light curves for the quiescent phase of V394 CrA and confirm that the parameters during the outburst are consistent with those in quiescence. Discussion follows in § 4, especially for relevance to SN Ia progenitors.

2. Light Curves for the 1987 Outburst

The orbital period of V394 CrA has been determined to be \( P = 0.7577 \) days by Schaefer (1990). Here we adopt the ephemeris of HJD 2,447,000.250 + 0.7577\( E \) at the epoch of the main-sequence (MS) companion in front. The orbit of the companion star is assumed to be circular. Our theoretical light-curve model has already been described in Hachisu et al. (2000a) for outburst phases and in Hachisu et al. (2000b) for quiescent phases of U Sco. The total visual light is calculated from three components of the system: (1) the WD photosphere; (2) the MS photosphere, which fills its Roche lobe; and (3) the accretion disk (ACDK) surface, the size and thickness of which are simply defined by two parameters, \( \alpha \) and \( \beta \), as

\[
R_{\text{disk}} = \alpha R_1^*, \tag{1}
\]

\[
h = \beta R_{\text{disk}} \left( \frac{\sigma}{R_{\text{disk}}} \right)^{\gamma}, \tag{2}
\]

where \( R_{\text{disk}} \) is the outer edge of the ACDK, \( R_1^* \) the effective radius of the inner critical Roche lobe for the WD component, \( h \) the height of the surface from the equatorial plane, and \( \sigma \) the distance on the equatorial plane from the center of the WD as seen in Figure 1. Here we adopt \( \sigma = 1 \) law \((\nu = 2)\), unless otherwise specified, to mimic the effect of flaring-up at the rim of the ACDK (e.g., Schandl, Meyer-Hofmeister, & Meyer 1997).

It has been established that the WD photosphere expands to a giant size at the optical maximum and then decays gradually to the original size of the WD in quiescence, with the bolometric luminosity being kept near the Eddington luminosity (e.g., Starrfield, Sparks, & Shaviv 1988). An optically thick wind is blowing from the WD during the outburst, which plays a key role in determining the nova duration because a large part of the envelope mass is carried away by the wind. The development of the WD photosphere during the outburst is followed by a series of optically thick wind solutions (Kato & Hachisu 1994). Each envelope solution is uniquely specified by the envelope mass, which is decreasing in time due to wind and nuclear burning. We have calculated solutions for five WD masses of \( M_{\text{WD}} = 1.377, 1.37, 1.36, 1.35, \) and \( 1.3 M_\odot \) with different hydrogen contents of \( X = 0.04, 0.05, 0.06, 0.07, 0.08, 0.10, \) and \( 0.15 \), in mass weight. The numerical method and physical properties of the solutions are described in Kato & Hachisu (1994) and also in Kato (1999), where we use the revised OPAL opacity (Iglesias & Rogers 1996).

Assuming a blackbody photosphere of the WD envelope, we have estimated the visual magnitude with a response function given by Allen (1973). For simplicity, we do not consider the limb-darkening effect. The early 10 days light curve of V394 CrA is mainly determined by the WD photosphere because the photospheric radius is larger than or as large as the binary size and much brighter than the MS and the ACDK. The decline rate during the early 10 days \((t \sim 1–10 \) days after the optical maximum) depends very sensitively on the WD mass but hardly on the hydrogen content (Kato 1999) or on the MS mass as described in Hachisu et al. (2000a). Thus, we obtain \( M_{\text{WD}} = 1.37 \pm 0.01 \) \( M_\odot \) by fitting of light curves.

The light curves are calculated for four companion masses, i.e., \( M_{\text{MS}} = 0.8, 1.1, 1.5, \) and \( 2.0 \) \( M_\odot \). Since we obtain similar light curves for all of these four cases, we show here only the results for \( M_{\text{MS}} = 1.5 \) \( M_\odot \). For a pair \( 1.37 \) \( M_\odot \) WD + \( 1.5 \) \( M_\odot \) MS, for example, we have the separation \( a = 4.97 R_\odot \), the effective radius of the inner critical Roche lobe \( R_1^* = 1.84 R_\odot \), and \( R_2^* = R_2 = 1.92 R_\odot \), for the WD and MS (Fig. 1), respectively.

In the plateau phase of the light curve \((t \sim 10–30 \) days), i.e., when the WD photosphere is much smaller than the binary size, the light curve is determined mainly by the irradiations of the ACDK and the MS as shown in the 1999 U Sco outburst (Hachisu et al. 2000a). Here we assume that the surfaces of the MS and of the ACDK emit photons as a blackbody at a local temperature of the surfaces heated by the WD photosphere. We assume further that half of the absorbed energy is emitted from the surfaces of the MS and of the ACDK (50% efficiency, i.e., \( \eta_{\text{ph,MS}} = 0.5 \) and \( \eta_{\text{ph,ACDK}} = 0.5 \)), while the other is carried into the interior of the accretion disk and eventually brought into the WD. The unheated surface temperatures are assumed to be \( T_{\text{ph,MS}} = 5000 \) K for the MS and to be \( T_{\text{ph,disk}} = 4000 \) K for the ACDK including the disk rim. The viscous heating of the ACDK is neglected during the outburst because it is much smaller than that of the irradiation effects. We have checked different temperatures of \( T_{\text{ph,MS}} = 4000, 6000 \) K and \( T_{\text{ph,disk}} = 3000, 5000 \) K but could not find any significant differences in the light curves.

The luminosity of the accretion disk depends strongly on both the thickness \( \beta \) and the size \( \alpha \) in the plateau phase. We have examined a total of 160 cases for the set of \((\alpha, \beta)\), which is the product of 16 cases of \( \alpha = 0.5–2.0 \) by 0.1 step and 10 cases of \( \beta = 0.05–0.50 \) by 0.05 step. Here we have adopted the same set of \((\alpha, \beta)\) as of the U Sco 1999 outburst (Hachisu et al. 2000a), i.e., \( \alpha = 1.4 \) (1.2) and \( \beta = 0.30 \) (0.35) for the
outburst wind phase (for the static phase). The hydrogen content \(X\) cannot be determined from the light-curve fitting mainly because the observation of the 1987 outburst does not cover the final decay phase toward quiescence. So we have adopted the same value of \(X = 0.05\) as in the U Sco 1999 outburst (Hachisu et al. 2000a). Then, the optically thick wind stops 20 days after the optical maximum as shown in Figure 2. Because the inclination angle of the orbit is not known yet, we have fitted the light curve by changing the inclination angle, i.e., \(i = 30^\circ, 45^\circ, 50^\circ, 55^\circ, 60^\circ, 65^\circ, 66^\circ, 67^\circ, 68^\circ, 69^\circ,\) and \(70^\circ\). Some of them are plotted in Figure 2. The visual magnitude of the 1987 outburst can be reproduced when the inclination angle is between \(65^\circ\) and \(70^\circ\) except for the first day of the outburst. It is almost certain that the visual light during the first day exceeds the Eddington limit because our optically thick wind solutions do not produce super Eddington luminosities.

Based on the best-fitted solutions, we have estimated the envelope mass at the optical maximum as \(\Delta M = 5.8 \times 10^{-6} M_\odot\), which indicates a mass accretion rate of \(\dot{M}_{\text{acc}} = 1.5 \times 10^{-7} M_\odot \text{yr}^{-1}\) during the quiescent phase between the 1949 and 1987 outbursts if no WD matter has been dredged up. About 77\% \((4.5 \times 10^{-6} M_\odot)\) of the envelope mass has been blown off in the outburst wind, while the residual 23\% \((1.3 \times 10^{-6} M_\odot)\) has been left and added to the helium layer of the WD. Thus, the net mass-increasing rate of the WD is \(\dot{M}_{\text{He}} = 0.34 \times 10^{-7} M_\odot \text{yr}^{-1}\).

The distance to V394 CrA is estimated to be 6.1 kpc for no absorption \((A_V = 0)\). We discuss the distance to V394 CrA in more detail, in the next section, to solve the discrepancy of the distance estimations between in-quiescence and in-bursting phases.

3. LIGHT CURVES IN QUIESCENCE

In a quiescent phase, we have adopted the same binary model in the 1987 outburst phase except for the disk shape (see Fig. 3), that is, we assume the WD mass as \(M_{\text{WD}} = 1.37 M_\odot\), the accretion luminosity of the WD as

\[
L_{\text{WD}} = \frac{1}{2} \frac{GM_{\text{WD}} \dot{M}_{\text{acc}}}{R_{\text{WD}}} + L_{\text{WD,0}}
\]

(e.g., Starrfield et al. 1988), and the viscous luminosity and the irradiation effect of the ACDK as

\[
\sigma T_{\text{ph, disk}}^4 = \frac{3G M_{\text{WD}} \dot{M}_{\text{acc}}}{8\pi R_{\text{WD}}^3} + \eta_{\text{ir, DK}} L_{\text{WD}} \cos \theta
\]

(e.g., Schandl et al. 1997), where \(L_{\text{WD}}\) and \(L_{\text{WD,0}}\) are the total and intrinsic luminosities of the WD, respectively; \(G\) is the gravitational constant; \(\dot{M}_{\text{acc}}\) is the mass accretion rate of the WD; \(R_{\text{WD}} = 0.0032 R_\odot\) is the radius of the 1.37 \(M_\odot\) WD; \(\sigma\) is the Stefan-Boltzmann constant; \(T_{\text{ph, disk}}\) is the surface temperature of the ACDK; \(\eta\) is the distance from the center of the WD; and \(\cos \theta\) is the incident angle of the surface. The accretion luminosity of the WD is as large as \(~1000 L_\odot\) for \(\dot{M}_{\text{acc}} \sim 1.5 \times 10^{-7} M_\odot \text{yr}^{-1}\). The unheated temperatures are assumed to be 4000 K at the disk rim and 5000 K at the MS photosphere.

Figure 4 shows the observational points (open circles) by Schaefer (1990) together with our calculated B light curve (thick solid line) for the suggested mass accretion rate of \(\dot{M}_{\text{acc}} = 1.5 \times 10^{-7} M_\odot \text{yr}^{-1}\). To fit our theoretical light curves with Schaefer's (1990) observational points, we have calculated B light curves by changing the parameters of \(\alpha = 0.5 - 1.0\) by 0.1 step, \(\beta = 0.05 - 0.50\) by 0.05 step, \(T_{\text{ph,MS}} = 3000 - 6000 \text{K}\) by 1000 K step, \(T_{\text{ph, disk}} = 3000 - 4000 \text{K}\) at the disk rim, \(L_{\text{WD, 0}} = 0 - 1000 L_\odot\) by 100 \(L_\odot\) step and 1000–5000 \(L_\odot\) by 100 \(L_\odot\) step, and \(i = 60 - 70^\circ\) by 1° step and seek the best-fit model for each mass accretion rate. The best-fit parameters obtained are shown in the figures [also see Table 1 for the other mass accretion rates (0.1–5.0) \(\times 10^{-7} M_\odot \text{yr}^{-1}\)].

Then we have calculated the theoretical color index \((B - V)\), for these best-fit models. Here we explain only the case of \(\dot{M}_{\text{acc}} = 1.5 \times 10^{-7} M_\odot \text{yr}^{-1}\) because the 1987 outburst model suggests an average mass accretion rate of \(~1.5 \times 10^{-7} M_\odot \text{yr}^{-1}\) during the quiescent phase between the 1949 and 1987 outbursts. By fitting, we obtain the apparent distance modulus of \(m_{B,0} = 17.66\), which corresponds to the distance of 34 kpc without absorption \((A_B = 0)\).
respectively. Then, we have a large absorption of theoretically calculated values and the observational values, variations.

\[ \text{About 0.5 mag sinusoidal variation can be reproduced with the inclination of } \theta. \]

On the other hand, we obtained a rather blue color index of \((B-V)_i = 0.16\) at \(m_B = 19.2\). This suggests a larger color excess of \(E(B-V) = (B-V)_i - (B-V)_c = 1.10\) with the observed color of \((B-V)_c = 0.94\) at \(m_B = 19.20\) by Schaefer (1990). Here the subscripts \(c\) and \(o\) represent the theoretically calculated values and the observational values, respectively. Then, we have a large absorption of \(A_V = 3.1E(B-V) = 3.46\) and \(A_B = A_V + E(B-V) = 4.56\). Thus, we obtain the distance of 4.2 kpc. Then, V394 CrA lies \(\sim 600\) pc below the Galactic plane (\(l = 352.84, b = -7.72\)).

The distance of 4.2 kpc indicates an absorption of \(A_V = 0.81\) during the outburst (6.1 kpc for \(A_V = 0\), i.e., \(A_V = 5 \log (6.1/4.2) = 0.81\). Then, we have \(E(B-V) = A_V/3.1 = 0.26\) and \(A_B = A_V + E(B-V) = 1.07\). On the other hand, Duerbeck (1988) suggested an absorption of \(A_B = 1\) from the nearby distance–interstellar absorption relation by Neckel & Klare (1980), which is consistent with our estimation of the absorption during the 1987 outburst. Thus, we may suggest that the intrinsic absorber of V394 CrA is blown off during the outburst as discussed in U Sco (Hachisu et al. 2000b).

4. DISCUSSION

Even for much different mass accretion rates, the distance to V394 CrA has been estimated not to be so much different from 4.2 kpc as tabulated in Table 1. For lower mass accretion rates such as \(M_{\text{acc}} = 1.0 \times 10^{-7} M_\odot \text{ yr}^{-1}\), however, we need the 100% irradiation efficiency of the MS (\(\eta_{ir,MS} = 1\)) or an intrinsic luminosity of the WD as large as \(L_{WD,0} \sim 300 L_\odot\) for the 50% efficiency (\(\eta_{ir,MS} = 0.5\)), in order to reproduce the \(-0.5\) mag sinusoidal variation. We also need an intrinsic luminosity of the WD as large as 300 \(L_\odot\) both for \(M_{\text{acc}} = 0.5 \times 10^{-7} M_\odot \text{ yr}^{-1}\) and for \(M_{\text{acc}} = 0.25 \times 10^{-7} M_\odot \text{ yr}^{-1}\) and 200 \(L_\odot\) for \(M_{\text{acc}} = 0.1 \times 10^{-7} M_\odot \text{ yr}^{-1}\), as summarized in Table 1.

The brightness of the system depends on various model parameters adopted here, that is, the efficiency of the irradiations \(\eta_{ir,DK}\) and \(\eta_{ir,MS}\), the intrinsic luminosity of the WD \(L_{WD,0}\), and the power of the disk shape \(v\). However, the distance estimation itself is hardly affected even if we introduce the different values of the parameters, as clearly shown in Table 2. Thus, we may conclude that the determination of the distance to V394 CrA in quiescence is rather robust as has already been shown in U Sco (Hachisu et al. 2000a, 2000b).

About 0.5 mag sinusoidal variation of the B light curve during the quiescence needs a relatively large reflection of the companion star as calculated in Figure 4, thus indicating a relatively large luminosity of the WD photosphere. If the intrinsic luminosity of the WD is negligibly small compared with the accretion luminosity (e.g., the nuclear burning is smaller than the accretion luminosity), the mass accretion rate should be higher than \(M_{\text{acc}} \gtrsim 1.0 \times 10^{-7} M_\odot \text{ yr}^{-1}\) because the efficiency of the irradiation effect must be smaller than 100%, which is consistent with our estimation of \(M_{\text{acc}} = 1.5 \times 10^{-7} M_\odot \text{ yr}^{-1}\) derived from the envelope mass at the optical maximum.

These systems with relatively high mass accretion rates are exactly the same as those proposed by Hachisu et al. (1999b) as a progenitor system of SNe Ia (see also Li & van den Heuvel 1997). Using the same simplified evolutionary model as described in Hachisu et al. (1999b), we have followed binary evolutions for various pairs with the initial sets of \((M_1, M_2, a_i)\), i.e., for the initial primary masses of

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![Image of theoretical B light curves](image_url)

**Fig. 4.** Top: theoretical B light curves (thick solid lines) plotted against the binary phase (two phases from \(-1\) to \(1\)) together with the observational points (open circles: data taken from Schaefer 1990). Bottom: theoretical B–V color light curves (solid lines) with no observational data points. Two additional light curves (thin solid lines: nonirradiated MS; dot-dashed lines: nonirradiated ACDK) are also plotted to show each contribution to the total \(B\) light. We assume the mass accretion rate of \(1.5 \times 10^{-7} M_\odot \text{ yr}^{-1}\). The other parameters are printed in the figures. About 0.5 mag sinusoidal variation can be reproduced with the inclination angle between \(i = 65^\circ\) and \(68^\circ\) but not with \(i < 60^\circ\) because of too shallow variations.

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### Table 1

| \(M_{\text{acc}}\) \((M_\odot \text{ yr}^{-1})\) | \(L_{WD,0}\) \((L_\odot)\) | \(\beta\) | \(\eta_{ir,MS}\) | \(m_{B,0}\) | \((B-V)_i\) | \((B-V)_e\) | \(E(B-V)\) | \(A_V\) | \(A_B\) | \(d\) \(\text{(kpc)}\) |
|---|---|---|---|---|---|---|---|---|---|---|
| \(5.0 \times 10^{-7}\) | 0.0 | 0.10 | 0.5 | 18.45 | -0.28 | 1.22 | 3.83 | 5.05 | 4.8 |
| \(2.5 \times 10^{-7}\) | 0.0 | 0.05 | 0.5 | 17.96 | -0.20 | 1.14 | 3.58 | 4.72 | 4.4 |
| \(1.5 \times 10^{-7}\) | 0.0 | 0.05 | 0.5 | 17.66 | -0.16 | 1.10 | 3.46 | 4.56 | 4.2 |
| \(1.0 \times 10^{-7}\) | 0.0 | 0.05 | 1.0 | 17.49 | -0.11 | 1.05 | 3.30 | 4.35 | 4.3 |
| \(1.0 \times 10^{-8}\) | 300 | 0.05 | 0.5 | 17.53 | -0.12 | 1.06 | 3.33 | 4.39 | 4.2 |
| \(5.0 \times 10^{-8}\) | 300 | 0.05 | 0.5 | 17.16 | -0.06 | 1.00 | 3.14 | 4.14 | 4.0 |
| \(2.5 \times 10^{-8}\) | 300 | 0.05 | 0.5 | 16.86 | +0.00 | 0.94 | 2.95 | 3.89 | 3.9 |
| \(1.0 \times 10^{-8}\) | 200 | 0.05 | 0.5 | 16.39 | +0.11 | 0.83 | 2.61 | 3.44 | 3.9 |

**Notes:** The inclination angle of the orbit \(i = 68^\circ\), the disk size \(x = 0.70\), the efficiency of the ACDK irradiation \(\eta_{ir,DK} = 0.5\), and the original temperatures of the companion \(T_{\text{ph,MS}} = 5000\) K and of the disk rim \(T_{\text{ph,disk}} = 4000\) K are assumed for all cases.

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Then, we obtain the present state of V394 CrA having the secondary mass of $M_{\text{MS}} = 1.39 M_\odot$ and the mass transfer rate of $M_{\text{MS}} = 1.6 \times 10^{-7} M_\odot$ yr$^{-1}$. In our evolutionary model, this binary system will soon explode as an SN Ia when the WD mass reaches $M_{\text{Ia}} = 1.378 M_\odot$. The mass transfer rate of our evolutionary model is consistent with $\sim 1.5 \times 10^{-7} M_\odot$ yr$^{-1}$ estimated from the light-curve fitting.

Finally, we may conclude that V394 CrA is the second strong candidate for Type Ia progenitors, next to U Sco (Hachisu et al. 2000a, 2000b).

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