TRANSITION-METAL OXIDES IN WARM CIRCUMSTELLAR ENVIRONMENTS

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We report on detections and simulations of electronic bands of transition-metal oxides, i.e. ScO, TiO, VO, CrO, YO, and of AlO, in spectra of two red novae V838 Mon and V4332 Sgr. These objects experienced a stellar merger event in 2002 and 1994, respectively, and have very rich circumstellar environments abundant in dust and molecules. We analyzed optical spectra of V838 Mon[a] which show a presence of outflowing material. In this object, electronic systems of oxides are observed in absorption against a photospheric spectrum which resembles that of a late-type supergiant. We present simulations of the absorption bands which allowed us to derive the excitation temperatures of 300–500 K and constrain column densities, which turned out to be very high. Among many interesting features discovered, we identified forbidden transitions of TiO in the $b^1\Pi$-$X^3\Delta$ and $c^1\Phi$-$X^3\Delta$ systems, which are seen owing to the high column densities and the relatively low temperatures. In the case of the older red nova V4332 Sgr[b], the main object is surrounded by a circumstellar disc which is seen almost edge-on and obscures the central star. The molecular spectra are seen in emission in this object, what is very unusual in astrophysical sources observed at optical wavelengths. We show that these emission bands arise owing to the special geometry of the star-disk system and that radiative pumping is responsible for excitation of the molecules. From the shapes of the rotational contours, we derive temperatures of about 120 K in this object. Remarkably, the spectra of V4332 Sgr contain features of CrO, which is the first identified signature of this molecule in an astrophysical object. In addition to the excitation and radiative-transfer analysis of the molecular spectra, we discuss chemical pathways that could lead to the observed variety of metal oxides seen in these enigmatic sources.

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[a] T. Kaminski, M. Schmidt, R. Tylenda, M. Konacki, and M. Gromadzki *ApJSuppl.*, **182** (33), 2009.
[b] T. Kaminski, M. Schmidt and R. Tylenda *Astronomy and Astrophysics*, **522** (A75), 2010.