

CSI 2264: Accretion process in classical T Tauri stars in the young cluster NGC 2264[★]

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ABSTRACT

Context. NGC 2264 is a young stellar cluster (~3 Myr) with hundreds of low-mass accreting stars that allow a detailed analysis of the accretion process taking place in the pre-main sequence.

Aims. Our goal is to relate the photometric and spectroscopic variability of classical T Tauri stars to the physical processes acting in the stellar and circumstellar environment, within a few stellar radii from the star.

Methods. NGC 2264 was the target of a multiwavelength observational campaign with CoRoT, MOST, *Spitzer*, and *Chandra* satellites and photometric and spectroscopic observations from the ground. We classified the CoRoT light curves of accreting systems according to their morphology and compared our classification to several accretion diagnostics and disk parameters.

Results. The morphology of the CoRoT light curve reflects the evolution of the accretion process and of the inner disk region. Accretion burst stars present high mass-accretion rates and optically thick inner disks. AA Tau-like systems, whose light curves are dominated by circumstellar dust obscuration, show intermediate mass-accretion rates and are located in the transition of thick to anemic disks. Classical T Tauri stars with spot-like light curves correspond mostly to systems with a low mass-accretion rate and low mid-IR excess. About 30% of the classical T Tauri stars observed in the 2008 and 2011 CoRoT runs changed their light-curve morphology. Transitions from AA Tau-like and spot-like to aperiodic light curves and vice versa were common. The analysis of the H α emission line variability of 58 accreting stars showed that 8 presented a periodicity that in a few cases was coincident with the photometric period. The blue and red wings of the H α line profiles often do not correlate with each other, indicating that they are strongly influenced by different physical processes. Classical T Tauri stars have a dynamic stellar and circumstellar environment that can be explained by magnetospheric accretion and outflow models, including variations from stable to unstable accretion regimes on timescales of a few years.

Key words. stars: formation – stars: variables: T Tauri, Herbig Ae/Be – open clusters and associations: individual: NGC 2264 – accretion, accretion disks

1. Introduction

Classical T Tauri stars (CTTSs) are young, low-mass stars ($M_* \leq 2 M_\odot$), with spectral types from F to M. They are surrounded by a circumstellar disk from which they are still accreting material. They present strong and broad emission lines in their spectra and show emission excess with respect to the stellar photosphere that goes from the radio to the ultraviolet (Bouvier et al. 2007b). CTTSs have strong magnetic fields (Johns-Krull et al. 1999; Johnstone et al. 2014) that disrupt the accretion disk at a few stellar radii from the star and channel the accreting material, forming accretion columns. The accreting gas hits the stellar sur-

face and creates hot spots. CTTSs also present cold spots at the stellar surface; these are caused by magnetic activity (Bouvier et al. 1995). Part of the gas in the inner disk region is ejected as a wind from the star-disk system along open magnetic field lines that may form collimated jets (e.g., Ferreira et al. 2006). In a few million years, before reaching the main sequence, CTTSs lose their disks and become weak-lined T Tauri stars (WTTs), which no longer show detectable signs of accretion (e.g., Meyer 2009).

A characteristic of CTTSs is the photometric and spectroscopic variability at various wavelengths. The photometric variability occurs from X-ray to infrared on a timescale from a few minutes to several years and is usually irregular (e.g., Appenzeller & Mundt 1989). Some stars, however, show periodic behavior, which may be due to the presence of stable

[★] Full Tables 2 and 3 are only available at the CDS via anonymous ftp to [cdsarc.u-strasbg.fr](ftp://cdsarc.u-strasbg.fr) (130.79.128.5) or via <http://cdsarc.u-strasbg.fr/viz-bin/qcat?J/A+A/586/A47>