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# Non thermal emission from T Tauri stars

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**Abstract.** T Tauri stars are low mass, pre-main sequence stars. These objects are surrounded by an accretion disk and present strong magnetic activity. T Tauri stars are copious emitters of X-ray emission which belong to powerful magnetic reconnection events. Strong magnetospheric shocks are likely outcome of massive reconnection. Such shocks can accelerate particles up to relativistic energies through Fermi mechanism. We present a model for the high-energy radiation produced in the environment of T Tauri stars. We aim at determining whether this emission is detectable. If so, the T Tauri stars should be very nearby.

**Keywords.** Radiation mechanisms: nonthermal, stars: pre–main-sequence, gamma rays: theory

## 1. Introduction

T Tauri stars are low-mass stars in their early stages of evolution. They are surrounded by an accretion disk and are actively accreting material from the disk (e.g. Feigelson & Montmerle 1999).

Variable thermal keV X-ray emission is detected from T Tauri stars. This emission comes from a high density plasma at a typical temperature of $\sim 10^7$. X-rays flares are considered as upscaled versions of solar flares, related to magnetic reconnection. Several works have been done on particle acceleration in magnetic reconnection (e.g. Zenitani & Hoshino 2001, de Gouveia Dal Pino *et al.* 2010).

Non-thermal radio emission from T Tauri stars have been detected (e.g. Ray *et al.* 1997, Loinard *et al.* 2008). Then, an acceleration mechanism for non-thermal particles must operate in these systems.

## 2. The model

We consider that a power-law population of relativistic particles (electrons and protons) is injected in the magnetosphere. These particles interact with the magnetic field, with the various radiation fields, and with the magnetosphere plasma. The values adopted for the different parameters in our model are: $R_{\rm m}$ (magnetosphere radius) 0.1 AU, $a$ (hadron-to-lepton energy ratio) 100, $q_{\rm rel}$ (content of relativistic particles) $10^{-4}$, $\alpha$ (particle injection index) 2, $v_{\rm w}$ (wind velocity) $2 \times 10^8$ cm s$^{-1}$, $B$ (magnetic field) $5\times10^2$ G, $n$ (maximum magnetospheric density) $10^{11}$ cm$^{-3}$ and $L_{\rm x}$ (X-ray luminosity) $10^{30}$ erg s$^{-1}$. The available power is estimated as $L = B^2/8\pi Ac$ where $A$ is the magnetosphere area.

The relativistic electrons lose energy mainly through synchrotron emission, inverse Compton (IC) scattering with the star radiation field and the X-ray radiation field, and through relativistic bremsstrahlung with the magnetosphere plasma. The relativistic protons lose energy mainly through synchrotron emission and $p-p$ inelastic collisions with ambient matter. The particles can escape from the acceleration region due to wind convection. The maximum energy for both types of particles is obtained equating the cooling rates with the acceleration rate $t_{\rm acc}^{-1} = \eta ecB/E$.

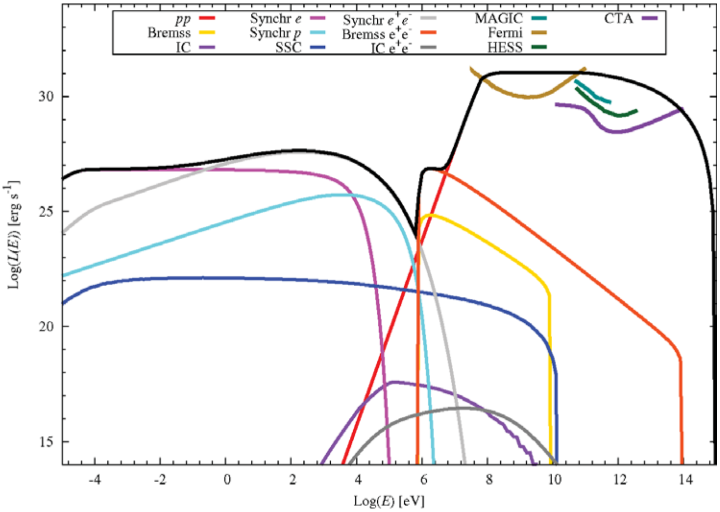

**Figure 1.** Computed SED for a source at d ~150 pc and the sensitivity curves for CTA, Fermi, MAGIC, and HESS.

The particles steady state distribution is calculated using the standard transport equation. We also consider the population of secondary $e^{\pm}$ pairs injected by charge pion decay (e.g. Orellana *et al.* 2007).

We calculate the processes of interaction of the relativistic particles with the fields in the magnetosphere (e.g. Vila & Aharonian 2009). The particles will collide with the accretion plasma columns which occupy a not well-established volume of the magnetosphere. We consider a small filling factor $f \sim 10^{-4}$. We also calculate the opacity from internal and external photon-photon absorption (e.g. Gould & Schréder 1967).

## 3. Results and conclusions

Figure 1 shows the computed spectral energy distribution (SED) and the sensitivity curves from gamma-ray detectors. We consider a source at a distance $d \sim 150$ pc, similar to that of the nearest T Tauri stars.

Some of the existing gamma-ray instruments should be able of detecting T Tauri stars with the characteristic adopted in this work. If so, these sources might be the closest gamma-ray sources ever observed.

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