Jets at all Scales
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Transient high-energy flares from accreting black holes

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Abstract. We present a model for high-energy flares in accreting black holes based on the injection in a magnetized corona of a non-thermal population of relativistic particles. Coupled transport equations are solved for all species of particles and the electromagnetic and neutrino output is predicted for the case of Galactic black holes.

1. Introduction

Several Galactic gamma-ray sources have been recently found to be rapidlyvariable. One of this sources is the well-known microquasar Cygnus X-1, which is a binary system composed by a massive star and an accreting black hole (Poutanen *et al.* 1997). The flaring nature of Cyg X-1 in gamma rays has been confirmed with the AGILE satellite (Sabatini *et al.* 2010).Different models have been proposed to explain the origin of these episodes (e.g., Romero *et al.* 2010; Zdziarski *et al.* 2009; Bosch-Ramon *et al.* 2008). These works are mainly focused on the analysis of gamma-ray emission that might be produced in the jet. The approach of this work is different: we consider the effect of the injection of non-thermal particles in the magnetized corona around the black hole. These particles can be locally accelerated by reconnection events and subsequent diffusive processes taking place on the plasma. Our main goal is to study coronal flares and their output in both electromagnetic radiation and neutrinos. In what follows, we outline the basic model and present the results of our calculations.

2. Static corona model

The model considered here is a static corona where the relativistic particles can be removed by diffusion. We consider a two-temperature corona in steady state, with a thermal emission characterized by a power-law with an exponential cutoff at high energies, as observed in several X-ray binaries in the low-hard state. For more details, an extensively description of this model can be found in Romero *et al.* (2010).

We solved the transport equation in steady state obtaining particle distributions. Then the spectral energy distributions of all radiative processes were estimated. We also took into account the effect of secondary pairs created by photon-photon pair production. Figure (1) shows the total SED together with the spectrum of Cygnus X-1, detected by COMPTEL McConnell *et al.* (2000) and the radio detection of the jet by Stirling *et al.* (2001).

It can be seen that emission in the range 100 MeV to 1 TeV is suppressed by absorption in the soft photon fields. All emission detected in this range should be produced in the jet at some distance from the blak hole (e.g., Bosch-Ramon *et al.* 2008; Romero *et al.* 2010).

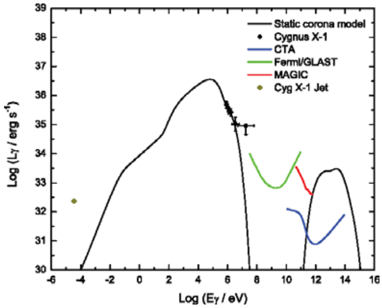

Figure 1. Spectral energy distribution obtained with the steady state model of a static corona. The prediction fits the observation made by COMPTEL of Cygnus X-1 (McConnell *et al.* 2000) and the detection of the jet by Stirling *et al.* (2001).

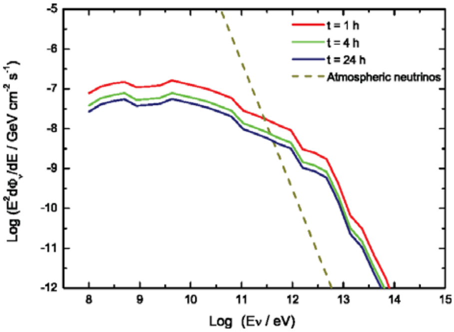

Figure 2. Evolution of the neutrino flux and atmospheric neutrinos.

However, if a sudden injection of relativistic protons occurs, for instance as a consequence of major reconnection events, a neutrino burst may be produced. We explore this scenario in this work.

3. Flare model

The temporal dependence of the particle injection is characterized by a FRED (Fast Rise and Exponential Decay) behavior, whereas the energy dependence is a power-law.

We consider neutrino injection by charged pion and muon decay. The differential flux of neutrinos arriving at the Earth can be seen in Fig. (2).

According to our results, a neutrino burst might be detectable in this kind of flares in accreting black holes. The electromagnetic part of the flare can be also detectable at some energies, depending of the optical depth for photon annihilation. A complete discussion will presented elsewhere.

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