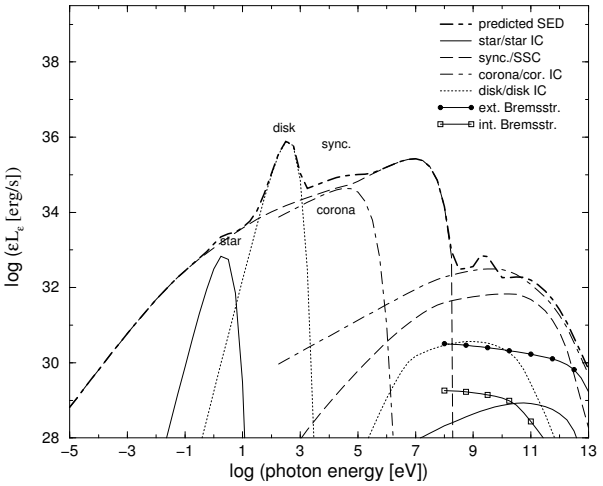

Fig. 2. Same for a low mass MQ. See also Vila & Romero (2010) for predicted HE features in the SED of the LMMQ GX 339-4.

cesses and effects, making then uneasy to estimate the properties of a source in unique way.

3. INTERACTING WITH A HIGH-MASS DONOR STAR

The detected γ-ray binaries are all of the high-mass kind. Two important ingredients are then provided by the star beside the matter supply for accretion: a dense soft radiation field and the strong wind where the jets propagate. Relativistic electrons upscatter the stellar photons to VHE through Inverse Compton (IC) interactions. Low-energy synchrotron photons radiated by the same electrons can also act as seeds for IC scattering, and then we speak of Synchrotron Self Compton (SSC). See e.g. Aharonian (2004) for a review on all the γ-ray production and absorption mechanisms.

The stellar radiation field can absorb gamma-rays by pair creation within the binary system. The optical depth is strongly dependent on the location of the γ-ray emission region if it is close to the compact object, and on the orientation of the system as seen by the observer. The attenuation has been found to be relevant for photon energies $\sim$10 GeV to 10 TeV, well within the observational range. Its study may help to set constraints on the location of the emission region (e.g. Dubus 2006b). In fact, this can be done for Cygnus X-1, which was detected in a configuration with the black hole behind the companion star, when the absorption of gamma-ray photons is expected to be highest (Romero, Del Valle, & Orellana 2010). At large optical depths, if the magnetic is low enough, electromagnetic cascades develop through a combination of pair creation and IC scattering, decreasing the effective opacity and considerably changing the spectrum (e.g. Bednarek 1997). Under a stronger ambient magnetic field in the region of gamma-ray absorption the energy of the pairs is channeled by the synchrotron radiation, and the cascade is suppressed (Khangulyan et al. 2008). As the pairs diffuse over the whole system, an extended broadband non-thermal emitter can arise (Bosch-Ramon, Khangulyan, & Aharonian 2008). Finally, a tunned magnetic field of intermediate strength can lead to a spatially extended cascade (e.g. Zdiarski et al. 2009) which needs of a careful treatment, i.e through 3D numerical simulations (e.g. Pellizza et al. 2010).

Stellar wind-jet interactions can also enhance the VHE emission: matter from the wind can penetrate the jet from the side, continuously diffusing into it as assumed by Romero et al. (2003), with the incoming (cold) nuclei acting as targets for inelastic hadronic collisions with the relativistic protons in the jet. The neutral pions created at such interactions decay emitting γ-ray photons, whereas the charged ones lead to the creation of energetic leptons and neutrinos (e.g. Reynoso, Romero, & Christianse 2008).

The jet propagation and integrity might be dynamically affected by the wind. Perucho et al. (2008, 2010) have found limiting conditions under which the jet can be disrupted by the growth of instabilities or suffer significant bending at the binary spatial scales. Concerning the wind structure, observational evidence supports the idea that winds of hot stars are formed by clumps. These inhomogeneities may interact with the jets producing a flaring activity at HE and VHE (e.g. Araudo et al. 2009). When the system contains a Be star, the presence of a dense equatorial outflow in addition to the tenuous stellar wind can strongly influence the matter accretion rate and therefore the lightcurve at HE (Romero et al. 2007).

The termination region of high-mass microquasar jets, or farther away, the dense and cold shocked ISM shell can be strongly modified by the jet impact. Large scale structures act as calorimeters, as in the case of SS 433 and Cyg X-1. The interaction of an SS 433-like jet with its external medium has been detected even in a nearby galaxy (Pakull et al. 2010). Bosch-Ramon et al. (2011) have studied the non-thermal emission related to this large spatial scales and found that hard X-rays and VHE photons may be the best probes to unveil the presence of microquasar jets interacting with their environment.