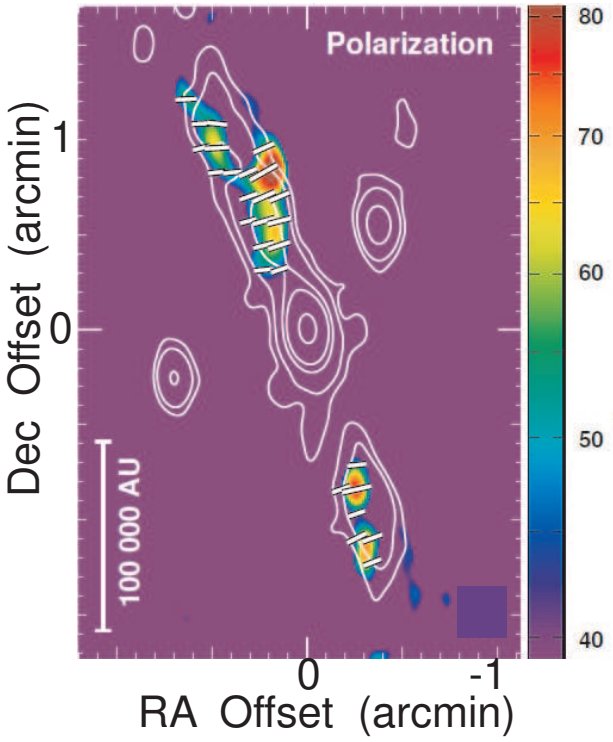

Fig. 6. Image of the HH 80-81 jet region at 6 cm wavelength. Linearly polarized continuum intensity image (color scale, units of μJy beam^{-1}). Polarization direction is shown as white bars. The total continuum intensity is also shown (contours; levels from 40 to 3300 μJy beam^{-1}).

protons accelerated at the jets or in their terminal regions, can give rise to high-energy emission.

Araudo et al. (2007) discuss inverse Compton interactions between the same relativistic electrons involved in the radio emission, and the infrared photon field of the molecular cloud that hosts the massive young stellar object.

The electrons can also cool through relativistic Bremsstrahlung. In both cases, the maximum energies are of the order of 1 TeV. If the acceleration process for environmental protons is effective, then inelastic collisions with the nuclei of the cloud can yield pions. Neutral pions decay producing gamma rays. Charged pions inject secondary pairs, which in turn can contribute to the synchrotron radiation observed in radio waves. Since the losses are less severe for protons, the radiation produced in processes at which they are involved can reach energies $\sim$10 TeV.

The various processes that can lead to gamma-ray emission inside a star-forming region are discussed in detail in Romero (2008, 2010).

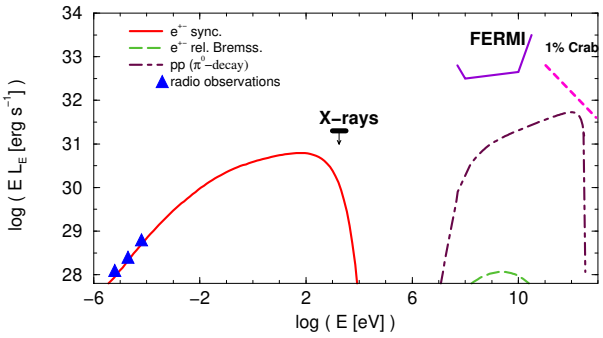

Fig. 7. Spectral energy distribution of the non-thermal emission for HH 80. Observational points are from Martí et al. (1993). The X-ray detection is shown as an upper-limit. The *Fermi* line stands for 1 yr/5σ sensitivity. The curve above 100 GeV corresponds to 0.01 Crab (Bosch Ramon et al. 2010).

A complete model of the source HH 80 has been recently developed by Bosch Ramon et al. (2010). It can explain the measured non-thermal radio emission but also predict a possible further detection with large Cherenkov arrays like CTA. Figure 7 shows the spectral energy distribution as it is expected from HH 80 (Bosch Ramon et al. 2010).

These works open a new window for the study of the star-formation processes, based on the detection of radiation produced by high-energy phenomena. In this way, gamma-ray astronomy can be used to probe the physical conditions in star-forming regions and particle acceleration processes in the complex environment of massive molecular clouds.

5. SURVEYS

The description of powerful forthcoming instruments like the SKA, ALMA, LOFAR and the numerous ways in which they will contribute in broadening the comprehension of the processes already mentioned have been widely covered. Instead, I would like to close this review outlying additional sources of information like radio surveys, that are focused on the earlier evolutionary phases of high-mass stars. A few projects were chosen, by way of examples.

The Galactic Census of High and Medium-mass Protostars or CHaMP[3] (Barnes et al. 2005). The survey consists of performing systematic observations with the Nanten Telescope at the lines of CO, ^{13}CO, C^{18}O and HCO$^+$, to identify massive dense molecular clumps within giant molecular

[3] http://www.astro.ufl.edu/~peterb/research/champ/.