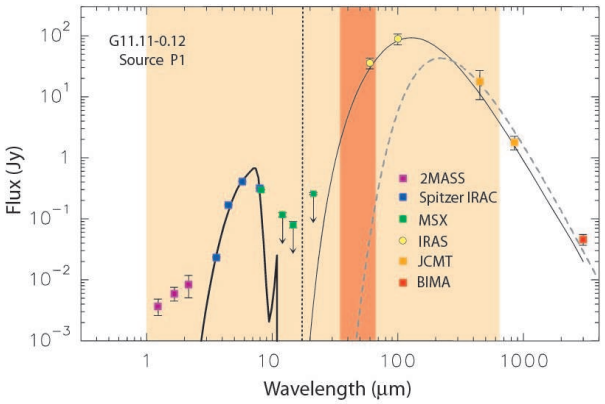

Fig. 3. Low-frequency SED of the infrared dark cloud G11.11-0.12 (Pillai et al. 2006). The color of the symbols stands for the telescope used. The sub-mm and mm fluxes appear to be produced by a protostar of 8 $M_\odot$, 1200 $L_\odot$ and T = 15000 K, with an envelope. The Spitzer-IRAC fluxes may represent a second object. The NIR emission can be produced by scattering from tenuous gas above a disk.

however, remain a nontrivial task. Non-thermal spectral indices and polarisation measurements at radio frequencies constitute fundamental informants.

Radio data can be obtained all-day long, and continuous instrumental developments have allowed to attain improved sensitivity and similar angular resolution than at other energy ranges (e.g., VLBA, EUV, APEX, Spitzer, etc).

Of the high-mass star forming stages, cold and hot dark clouds are radio observables and, later, hyper compact, ultra compact and regular ionized regions (Zinneker & Yorke 2007; Beuther et al. 2007).

3. SOME DISCOVERIES AND EXAMPLES

In the context of star-forming regions and protostellar objects, the term radio jet commonly refers to a collimated flow of ionized gas, with velocities of $\sim$100 km s^{-1}, formed by the primary wind from the inner part of a star-disk system. On the other hand, gas of the environment, accelerated by interaction with the wind, forms lobe-shaped structures. This gas, moving at velocities of tens of km s^{-1} represents the well-known molecular outflows (Bachiller 2009).

Radio observations of stellar jets and outflows were only possible with the advent of modern radio interferometers. Some historical significant papers are reviewed below.

In 1980, both Snell et al. (1980) and Rodríguez et al. (1980) presented evidence of molecular outflows in star forming regions. The former group, of CO outflow lobes of $\sim$0.5 pc from L1551, a cloud that includes the objects HH 28, 29, and 102. The latter, through detection of high-velocity CO wings toward the SRF of Cep A, at 50 km s^{-1}, 0.3 pc long. Pravdo et al. (1985) could image, for the first time, the ionized emission from a HH object (HH 1–2).

Rodríguez et al. (1989) discovered the first non-thermal jet of a SFR in Serpens. Later, Martí et al. (1993) reported on VLA observations of very collimated jets towards the luminous HH 80-81 ($\sim 2\times10^4$ $L_\odot$, d = 1.7 kpc). Radio counterparts of HH 80 and 81 are aligned with an exciting source, about 2.3 pc to the south, linked by a patchy jet-like structure. A radio source named HH 80 North was discovered, symmetric to the corresponding southern one with respect to the central object. The spectral indices up to 10 GHz resulted positive ($S_\nu \propto \nu^\alpha$) for the central source, and negative for HH 80, 81, and 80 North. Gómez et al. (2003), using VLA data, determined the spectrum of the central source, and could detach the contributions of a protostellar disk and a collimated jet. Very recently, Qiu & Zhang (2009) were able to detect episodic molecular bullets ($\sim$100 km s^{-1}) that would be ejected close to the central source.

Observations of water masers were soon used to physically describe young stellar objects. Torrelles et al. (1996) mapped H_2O emission, probably coming from a disk around a protostar with jets, in Cep A - HW2 region. Very recently, new VLBI maser observations (Torrelles et al. 2011), were performed over Cep A HW2. The data were taken at five epochs to measure proper motions of the maser spots. They found masers remaining static at 1 arcsec scale, but at shorter scales they draw an ellipse, supposedly around an unseen YSO. The final results can be explained with two molecular outflows: one slow ($\sim$50 km s^{-1}), at a wide angle (100°), and a second collimated (20°) fast gas jet ($\sim$500 km s^{-1}). They also saw hints of a rotating wind around a central mass protostar of 20 $M_\odot$.

Alcolea et al. (1993) have reported dramatic evidence for bipolar flows too, based on the proper motions of water maser spots from a source named "TW", close to W3(OH), from VLBI observations. The results encouraged a study by Reid et al. (1995) who used archive VLA data from 4 to 15 GHz to derive a non-thermal spectral index α for TW of -0.6, and size decreasing with frequency. Wilner et al. (1999), by means of dedicated VLA observations at 8.4 GHz, confirmed the previous results, consistent with emission produced by a synchrotron jet.

By the same time, Ray et al. (1997) could measure with MERLIN, at less than 0.1″ scale, circularly