Astronomy 130   Assignment 4
Due Tuesday May 4, 2010

Newly born stars or protostars are always found in the vicinity of molecular and ionized gas clouds. An important phase of the evolution of newly born stars is out-flow activity when a stellar jet interacts with the surrounding interstellar medium. Here we study the nature of a jet from a newly born young star which is embedded within its parent dust cloud. We measure the motion of Herbig Haro (HH) 399 jet across the plane of the sky using the Hubble Space telescope observations made in 1997 and 2002. The fourth assignment deals with "Trifid" Nebula.

The main purpose of this exercises is to find out how fast the jet of a low mass protostar (HH399) is moving across the sky or to measure the proper motion of the jet. We determine the proper motion by comparing Hα images of the jet taken five years apart and search for a shift in the position of the emission. You first need to choose a rectangular box around the jet.

In order to measure the proper motion value, you first need to compare two images that are taken five years apart. If we subtract the images taken in 1997 and 2002, we should be able to notice that the regions from which the emission from the jet arises has large errors. This is because two images are shifted with respect to each other and obviously the emission does not cancel out. If there were no proper motion, the subtracted images should show the emission cancels out. The subtracted image shows large RMS (root mean square) errors if the jet is moving. So, if we shift each image by certain pixel number, then the subtracted images with minimum RMS errors should give us clues as to how much the image taken in 2002 has shifted with respect to that taken in 1997.

Answer the following questions.

1) Find the minimum and maximum values of RMS.

2) State the shift in the number of pixels in the X-axis corresponding to the minimum RMS

3) The Hubble image has a pixel size of 99.6 milli-arcsecond. What is the proper motion of the jet in arcsecond after five years of the motion of the flow along the jet?

4) The distance to HH399 is 2670 pc. Find the total length that the jet has traveled in five years in pc and in kilometers.

5) What is the speed of the jet in km/s (use the answer from 4) and divide it by five years).