ASTR 106 Laboratory   Age of the Crab Nebula Supernova Remnant

• Due at the start of class on Wednesday, November 2
• Use a computer to access the lab at **http://astro.wku.edu/astr106/crabexpansion/**
• Carefully read and complete the activity as instructed. If something is not clear, ask for help.
• Neatness counts. Information which is difficult to decipher will not receive credit.
• Everything turned in for a grade must be your own work. Collaboration is not acceptable as
 you undertake the work required to fill out this worksheet.
_____

In this lab, you will use two images of the Crab nebula obtained 43 years apart to determine
the rate of expansion of the Crab nebula and its age. You will input your measured values
from online images into an excel spreadsheet which will perform the required calculations.
You will print out and turn in the spreadsheet along with the answers to the questions at
the end of the lab. The images and spreadsheet are at astro.wku.edu/astr106/crab.html.

Part 1: Scale of the images.

The first task is to determine the scale factor of the images. There are two stars in each
image with an arrow pointing at them. As you scroll the mouse over the picture, notice in
the lower left hand corner of the browser window some text appears and at the end there
are two numbers separated by a comma. These are the image coordinates of whatever is
underneath the mouse and are in order (x, y). **If you do not see these, try to expand the
window. If not, try another browser! I know it works in Firefox and Internet Explore,
but not in Safari.** For both images of the Crab nebula record the x and y position of the star
with the arrow pointing at it on the excel spreadsheet. The sheet will take these numbers
and automatically calculate the scale factor.

Part 2: Measuring the knots and calculating the age

There are links on the main page to each image (1956 Image of the Crab Nebula and 1999
image of the Crab nebula). There is also a link to the excel spreadsheet; you must use this

link to download the excel spreadsheet. On
each image, the central pulsar and 10 knots
are labeled. By measuring the change in the
position of each of these knots relative to the
central pulsar between the two images, we
can calculate the expansion rate and thus the
age of the Crab nebula. The pulsar's position
is already entered into the spreadsheet; **do
not change this**. Click on the 1956 image
link. Position the cursor between the lines
marking each knot, and record in the
spreadsheet the x and y position of each knot
found in the bottom left hand corner of the
page. **NOTE: do not double click on the
image, if you do, you will get an error
message. If that happens use the browser's back button to return to the image.** Return
to the main page and click on the 1999 image of the Crab nebula link. Repeat the above
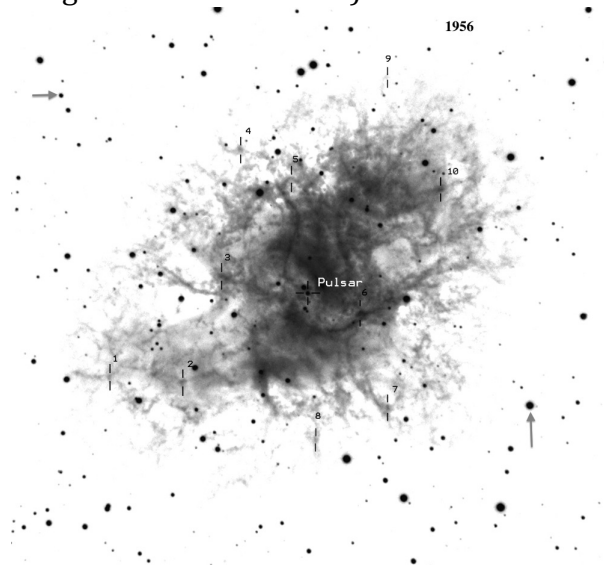
process for measuring and recording the positions of the knots. The spreadsheet will convert your picture coordinates to a distance in arcseconds, which is the distance of the knot from the pulsar measured on the sky. It will then use the time difference between the two photographs and determine the velocity the knot has been traveling in arcseconds/year. Using that and the formula velocity X time = distance, it calculates how long ago the SN occurred (assuming the knots started moving when the supernova occurred) and then calculates the age and an uncertainty in the age of the supernova. Use this information to answer the questions below. **Print out and turn in the excel sheet and this sheet with the answers to the questions below. When you print the excel sheet, please print it so it fits on one page.**

Questions:
1) Clearly explain the assumption about the knot's velocity that you have to make for this calculation to be valid.

2) Using the uncertainty in the age of the Crab nebula, show your work and determine the earliest date the supernova event could have occurred.

3) Showing your work, determine the latest data the supernova could have occurred?

4) Explain how your value for the date of the supernova compares to these two extremes, and discuss the implications of your result.

5) Explain how the actual date of 1054 CE compares to these two extremes.