1 Ay 20 observing proposals

Modified/combined versions of three of the submitted observing proposals have been accepted for execution as two observing projects on the P60.

Please pick one of these two to work on for your class observing project.

2 Star Formation in Interacting and Non-Interacting Galaxies

2.1 Scientific Motivation

Luminous stars hot enough to produce signficant numbers of photons capable of ionizing hydrogen (i.e. $h\nu > 13.6$eV, or $\lambda < 912$Å) have short lifetimes (less than about 10^7 years). Since the orbital period in a galaxy is typically several times 10^7 years, it takes more than a stellar lifetime to remove gas left over from the formation of such stars. Hence galaxies with hot young stars in them typically also have lots of gas in them, and the hot stars ionise it. In equilibrium, the rate of recombination of hydrogen equals the rate of ionisation, so such galaxies have strong $H\alpha$ emission lines produced by recombination of the hydrogen, as shown in Figure 1. Galaxies with little or no recent star formation have weak or absent $H\alpha$ lines.

It is furthermore believed that when galaxies undergo collisions, the strong shock waves induce rapid star formation in gas in the colliding galaxies. Galaxies with the highest known star formation rates all show evidence of current or recent collision with another galaxy.

The plan is to investigate this phenomenon by comparing the $H\alpha$ line luminosities of three galaxies: one isolated galaxy, and two interacting galaxies, with the goal of seeing of the star formation rate, as indicated by the $H\alpha$ line luminosity (or equivalent width -you will have to think about the best measure) is indeed higher in the interacting galaxies.

Observationally, this will be done by imaging each of the galaxies twice with two different narrow band filters: one centered at the (redshifted) $H\alpha$ line for each galaxy, and one nearby in wavelength but not transmitting $H\alpha$. Subtraction of the two will give the flux in the $H\alpha$ line (but see figure 1's caption for a subtlety).

A not necessarily complete list of issues to be addressed:

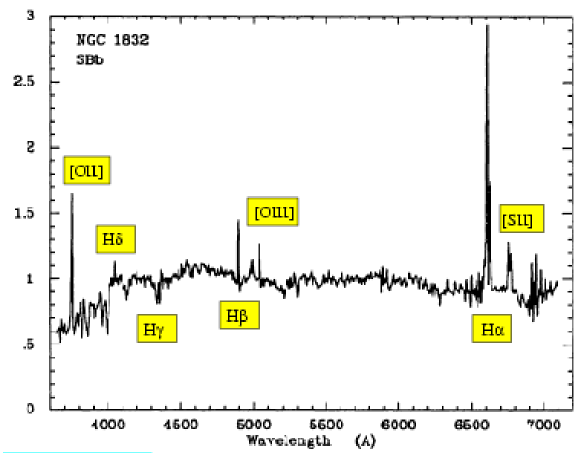
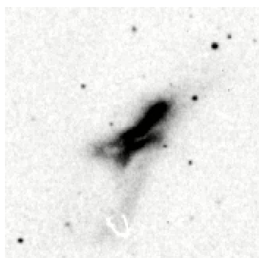


Figure 1: Figure 1. Spectrum of the star-forming spiral galaxy NGC 1832. Vertical axis is F_λ, rescaled so $F_{5550\mathring{A}} = 1$. If you look closely at the line labelled $H\alpha$, you will see that there are actually two lines close together. The longer wavelength one is a line of [NII]. These will both be transmitted in our narrow band "$H\alpha$" filters.

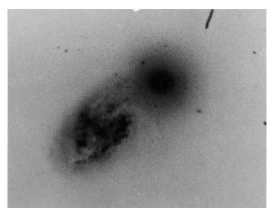
- The list of P60 narrowband filters is at http://www.astro.caltech.edu/~ams/P60/filters.html They are about 20Åwide, but the graphs of the transmissions are known to be wrong in both wavelength and width. A volunteer is needed to remeasure these as part of their project!
- Calibration of the P60/CCD/narrow band filter set by standard star observations before and after each galaxy observation.
- Reduction (flat fielding, cosmic ray removal, etc) of the galaxy images and subtraction of "off" and "on" band images.
- Determination of the total and local (where is SF peaked?) Hα flux.
- What can one do about extinction by dust in the galaxies?
- Estimation of star formation rates. Theoretical relation between $L[H\alpha]$ and star formation rate?

2.2 The Observational Plan

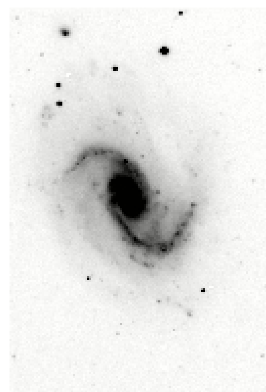
For this project, we have three targets: two interacting systems and one non-interacting. NGC 520 is a merging pair of spirals that has been extensively modelled and observed from radio through x-ray. Arp 140 is an interacting Sc and E0. NGC 895 is a reference Sc galaxy from the Shapley-Ames catalog. Postage stamps and coordinates are listed below.



NGC 520



Arp 140



NGC 895

Name	RA	Dec (J2000)	z	On, off bands
NGC 520	01:24:35	03:47:33	0.0076	6614, 6564
Arp 140	00:51:03	-07:03:42	0.0058	6603, 6564
NGC 895	02:21:37	-05:31:17	0.0076	6614, 6564

We have several options for spectrophotometric standard stars with which to calibrate the photometry: GD50, G191-B2B, and HZ2, all of which were recently observed with P60. (See http://www.eso.org/sci/observing/tools/standards/spectra/stanlis.html for the reference spectra.)

The total integration should be about 30 minutes per object, per filter, judging from Hα surveys on telescopes of the same size. We can now double-check this with the newly-observed standards. Unfortunately P60 is unguided, which puts a hard limit of 300 s on observations, and about 180 s if image quality is a concern. Therefore, this will require about 10 exposures of 3 minutes each.

3 Tumbling Asteroid

3.1 Scientific Motivation

One interesting question about asteroids and Kuiper Belt objects is whether they are actually solid rocks, or “rubble piles” held together loosely just by gravity. One way to distinguish these is by their shapes and rotation rates (rubble piles would fly apart if they rotated too rapidly). Another interesting question is what determines their rotation rates. Collisions with other asteroids? Tidal effects during close encounters with planets? Radiation pressure torques (an asteroid dark on one side and lighter on the other will tend to spin up)? Yet another is the question of damping: some asteroids tumble (rotate not about one of their principal axes), which causes fluctuating strains in their interiors. Damping of these drives it to eventually rotate about a principal axis. Tumbling asteroids thus tell us about the time since rotation was imposed, and the interior structure of the asteroid. This project aims to measure the rotation of an irregular asteroid by photometry.

3.2 The Observational Plan

The original student proposal was to measure the tumbling KBO Haumea (now a dwarf planet). Unfortunately it is not observable this month (too close to the sun), so we chose the asteroid 1484 Postrema in its place. It was discovered in 1938 and has a very well known orbit. Its lightcurve has a peak-to-peak amplitude of about 0.25 mag and a period of 12.2 hours. We intend to observe the object on 4 nights, separated by 5 days. Each night will have 3 sets of two 60 s V-band exposures, with the sets separated by 1 hour. When the object is reobserved 5 days later, the starting time will move forward 1 hour. (Note that 5 days corresponds to about $10 \times 0.2 = 2$ hours later in the period.) With this we hope to sample the full phase. For instance: 4 Nov 0630, 0730, and 0830 UT; 9 Nov 0730, 0830, 0930 UT; and so on.