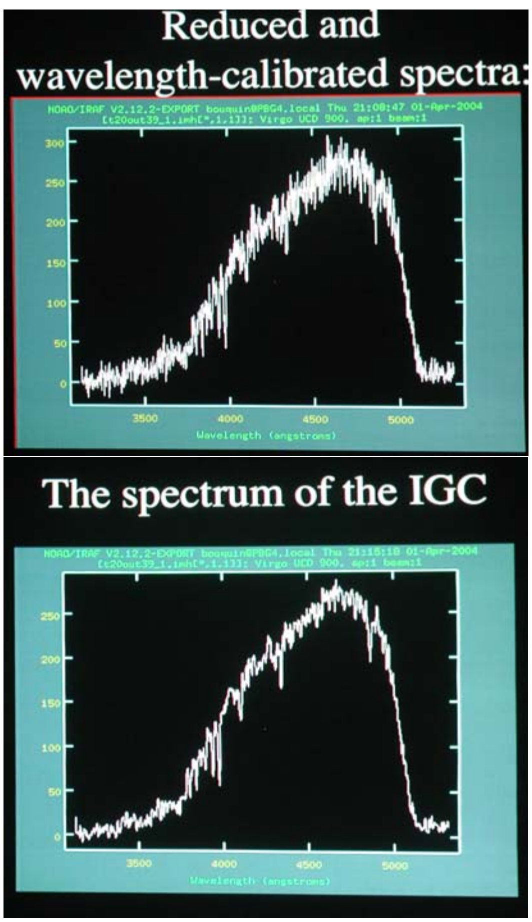
ASTROTENT

January 2007

The focus of December's NYAA meeting was a presentation, titled "My Cosmic Voyage", by Alexandre Bouquin, a graduate student at the University of Toronto. Alex graduated with a Bachelor of Science from the University of Hawai'i at Hilo in 2004. He then worked as a research assistant at Gemini North, before starting his Master's degree at U of T in 2006. He did make passing mention of the surf, sunshine and sandy beaches abundantly present in Hawai'i. Not that he misses any of that, compared to what Toronto has to offer.

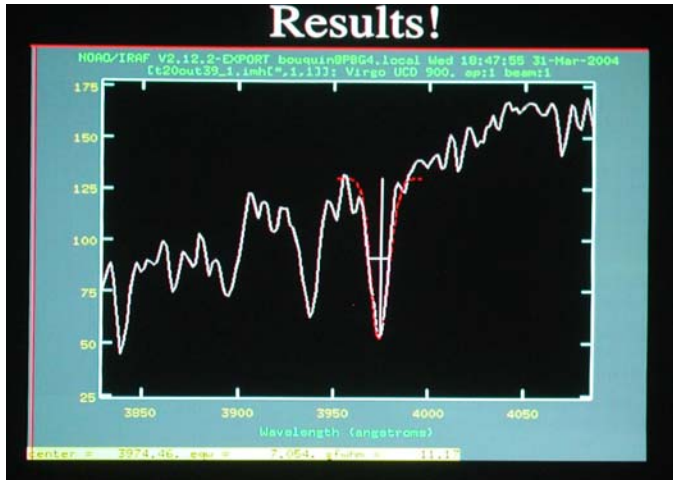
Alex started off by describing some of his work on a team investigating Intergalactic Globular Clusters. Normally, globular clusters from a loose halo around the galactic core. However, a supposed globular cluster was found on a Hubble image of the Virgo galaxy cluster. This putative cluster was far removed from any host galaxy, but without definitive spectroscopic evidence, its nature could not be confirmed.

The Subaru and Keck telescopes on Mauna Kea were used to obtain spectra, from the UV to near infra-red, of objects in the Virgo cluster (50 million light-years distant) and Abell 185 (400Mly). These spectra had to be "reduced", i.e. remove any bias, subtract the dark frames and flatten the image to account for "hot" pixels. They also had to be calibrated against known spectra, as from an arc lamp. The spectra were then analyzed to look for absorption lines. The object in the Hubble image was found to have a radial velocity of about 450 km/s, roughly the same as the Virgo cluster itself. Its spectra and luminosity distribution was also characteristic of a normal globular cluster.



Wave-length calibrated spectrum and the spectrum of the suspected IGC

Further, its visual magnitude (21.2) corresponds to a typical globular cluster at a distance of 50Mly. The team concluded that intergalactic globular clusters do exist – there's at least one of them!



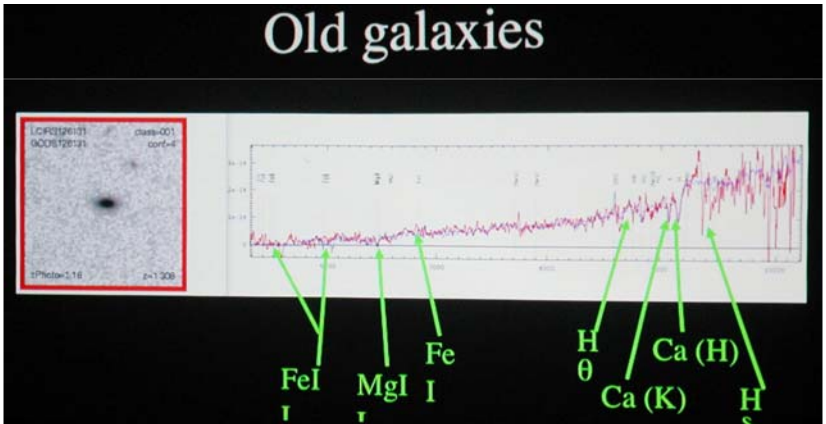
Absorption line feature in spectrum of intergalactic globular cluster

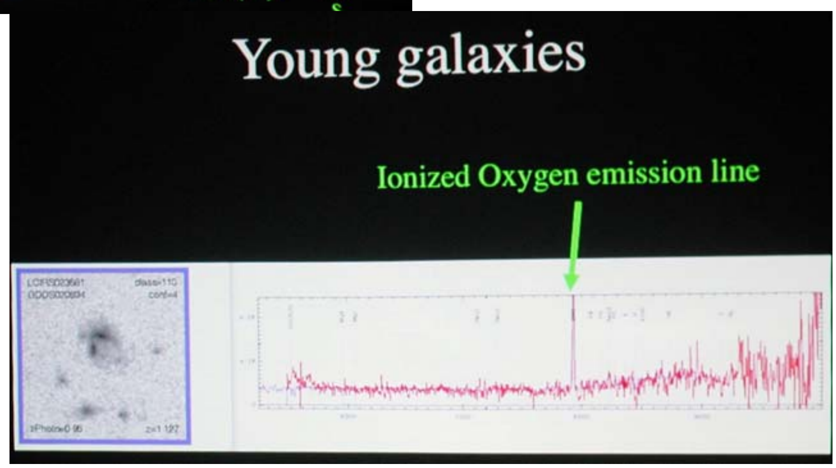
The second part of Alex's presentation was about his participation in the Gemini Deep, Deep Survey. The telescopes on Mauna Kea are at and altitude of 4207 metres above sea level. At this altitude, infra-red observation is still possible, especially with the large aperture (8.2m) Gemini instrument. The "seeing" on Mauna Kea is typically better than a half-arcsecond and there is virtually no light pollution, even though it is only a two and a half hour ride down the mountainside to a major population area. Nighttime clouds forming at about the 3000 metre level effectively extinguish any light from the towns at sea-level.

The Gemini Deep Deep Survey involved obtaining spectra of galaxies in four fields. The integration times were between 21 and 38 hours. The aim was to get usable spectra of galaxies in the so-called "redshift desert". Typical redshifts are determined by comparing the observed wavelength of light with a calibrated standard. Due to the expansion of the universe, the spectral lines of distant galaxies are shifted toward the red end of the spectrum. At certain distances, these lines are shifted into the infra-red, which is effectively absorbed by the Earth's atmosphere and thus become virtually invisible to ground-based telescopes. Therefore there is a relative paucity of galaxies observed with redshifts between z=1 and z=2. (Beyond this range, spectral lines emitted in the far ultra violet are shifted into the visible region and so can be detected).

Gemini is well suited to going after these mid-z galaxies: Its 8.2 m aperture collects far more light than Hubble's puny 2.4m. It has adaptive optics. It is above a sizeable fraction of the Earth's atmosphere. These factors, coupled with long integration times and special techniques to account for "sky glow", allowed Gemini to obtain high quality spectra of galaxies in several Hubble fields.

The spectra allowed the galaxies to be classified as young, old or intermediate and provided estimates of star formation rates in each galaxy. In addition the redshift provided an estimate of distance. The data indicated that there were a surprising number of "old" galaxies when the universe was half its present age. Correlating the Gemini spectra with Hubble images showed that "old" galaxies tended to have a smooth light distribution, while "young" galaxies appeared lumpier. Of course, as with most scientific endeavours, there were some galaxies that defied classification.

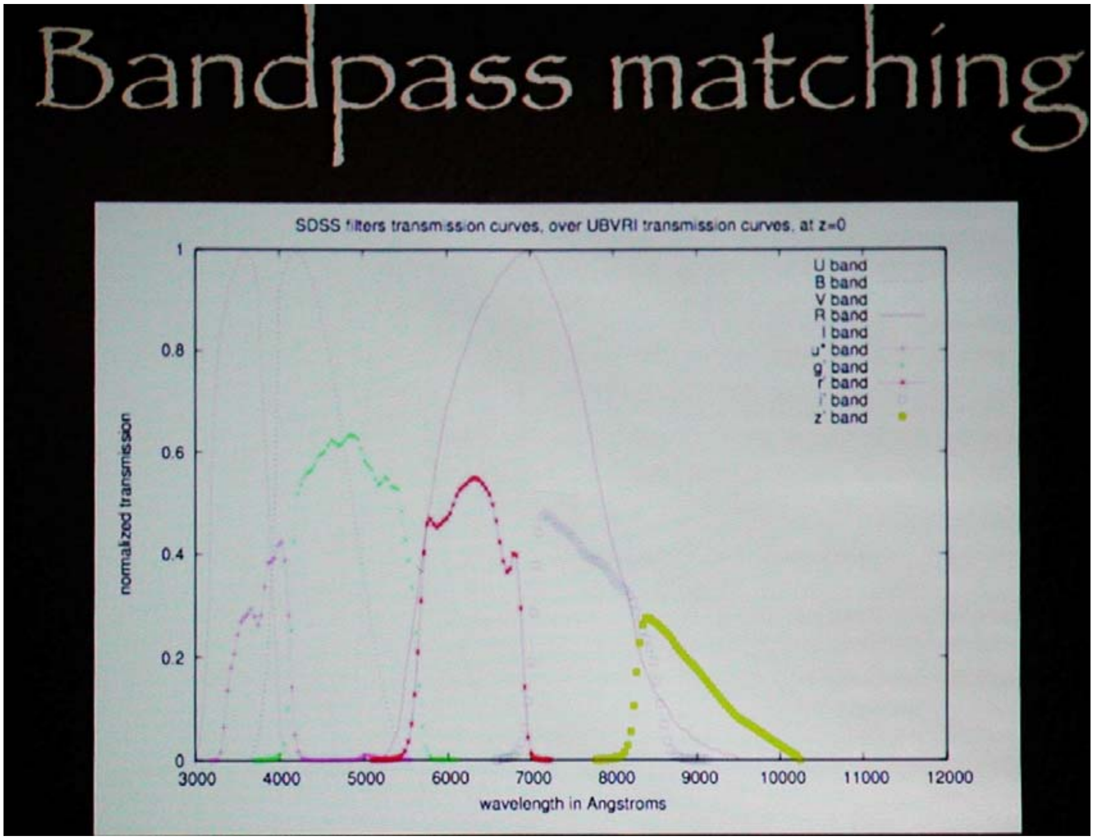




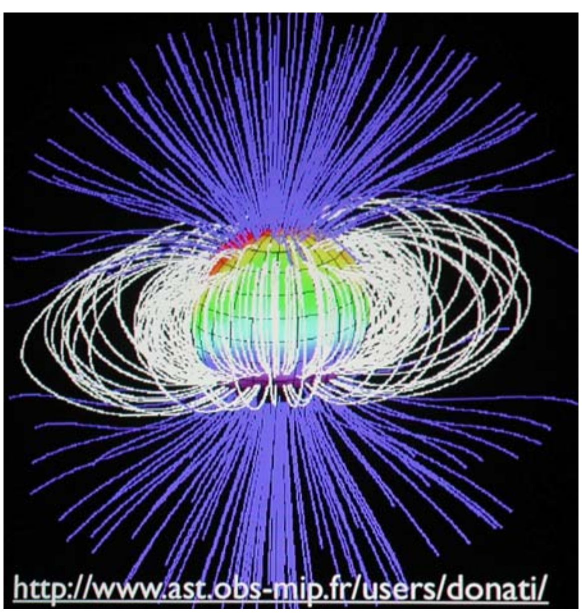
Alex's next topic was the Supernova Legacy Survey (SNLS). This was a study of type II-P supernovae found by CHFT, using the technique of repeated wide-field imaging. Supernovae candidates were discovered by comparing images of the same field taken at different times. Follow-up light curve and spectra were obtained for promising candidates using the Gemini, VLT and Keck telescopes

Supernovae can be broadly classified into two types: Type I have no hydrogen lines in their spectra, and Type II do have hydrogen lines in their spectra. Type II-P have a plateau (hence the P) in their light curve. Type II-P progenitors are thought to be massive stars which have a large hydrogen shell.

The light curves of the Type II-P supernovae in the SNLS were compared to light curves from the Padova-Asiago supernovae catalogue. This was not exactly a cheesecake-walk (sorry!), since the light curves were obtained using different types of filters. The data had

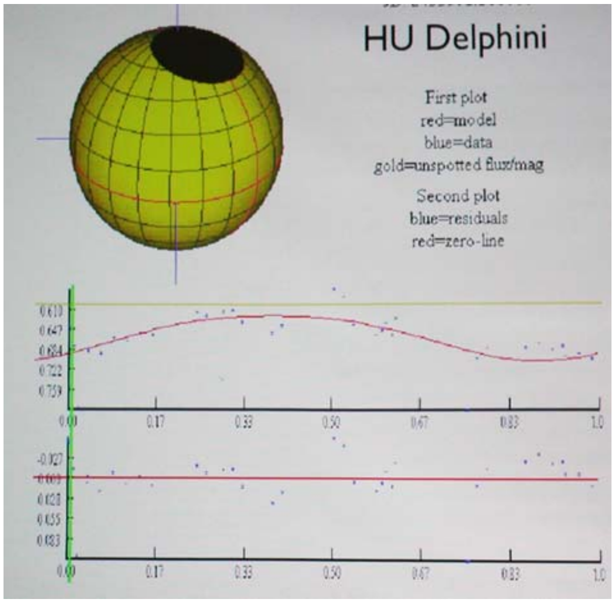


to be manipulated to apply corrections to the filter band pass so that absolute visual magnitudes could be meaningfully compared. The data indicated that supernovae at a redshift of $z \approx 1/3$ were brighter than $z = 0$ supernovae by 1 magnitude. The cause of this is not understood, but may be due to a selection effect, i.e. it is easier to see brighter supernovae across cosmological distances.



In the final part of his spoken presentation, Alex told us about his current work at the University of Toronto in which he used a six-inch refractor to obtain light curves of fast-rotating M-type dwarfs. These stars are thought to possess relativey strong magnetic fields which may produce “star spots” (akin to sun spots). Large spots on the surface should be evinced by periodic variations in the star’s lightcurve.

The six-inch refractor, located in the middle of Toronto, had a few mechanical problems.



These were overcome using old-fashioned elbow grease, a cardboard washer for the colour filter wheel, and the liberal application of alcohol. As one wag noted, alcohol is the cure for many a problem.

Alex was able to obtain light curve data on twelve nights between June 20th and August 31st, 2006. He had four target stars and ended up being able to determine the rotation periods of two of them – each was less than 12 hours. The best-fit light curve for one of the stars (HU Delphini) showed that it likely had a large spot near its rotation axis.

Alex concluded his presentation by showing a video he assembled from public-domain astronomy images with a musical accompaniment. This video showed our home solar system and ventured our far into the realm of galaxies – truly a cosmic voyage!

A Canticle For Pluto

(*With apologies to Paul Simon, this is sung to the tune of "The Sound of Silence"*)

Goodbye Pluto, my old friend
We won't be seeing you again
Because the IAU Prague meeting
Turfed you out while I was sleeping
And the system that was planted in my brain
Won't remain
Without the planet Pluto

The solar system's outer zone
Into chaos now is thrown
With the vote of the IAU
You're not a planet in their cosmic view
And your place was robbed by a vote in the dead of night
Without a fight
To bring an end to Pluto

And in the darkened night I saw
A bunch of planets, maybe four
Planets shining without twinkling
Planets rising and then setting
Planets large and small that no one ever feared
But then they dared
To say "Farewell" to Pluto

"Rules" said they "are ours, you know
Else the list of planets grow
Hear our words that we might lead you
Take our views and we won't beat you"
But their words, like acid raindrops fell
And they meant
There's no room for Pluto

And the planets rolled and stayed
In the orbits that they made
And the IAU kept writing
Out the list that it was forming
And the list said "The planets in our sky are more than little icy balls
Where darkness falls"
And added "Say goodbye to Pluto"