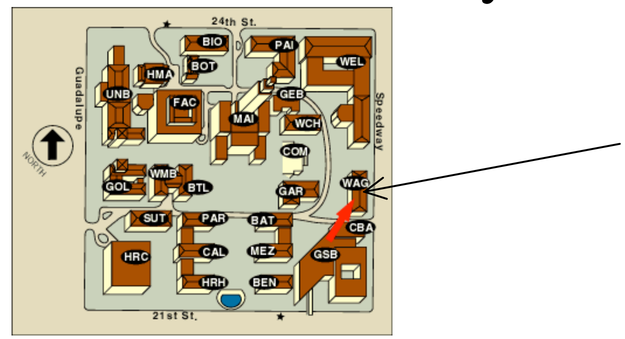
September 29, 2010

Exam 2 This Friday. Review sheet posted. Review Thursday 5 PM Waggener 214, South of Welch Hall



Reading, Sections 6.4, 6.5, 6.6.

Sections 1.2, 2.1, 2.4, 2.5, 3.3, 3.4, 3.5, 3.10 (binary stars), 4.1, 4.2, 4.3, 4.4 (accretion disks), 5.2, 5.4 (cataclysmic variables) for background

Chapter 7 will be on 3rd exam.

Astronomy in the News? Senator Kay Bailey Hutchinson brokers a deal to fund NASA

Pic of the Day – Fly me to the Moon, let me sing among those stars. Let me see what spring is like, on Jupiter and Mars…

Sky Watch Objects mentioned so far

Lyra - Ring Nebula, planetary nebula in Lyra

Cat’s Eye Nebula, planetary nebula in constellation Draco

Sirius - massive blue main sequence star with white dwarf companion

Algol - binary system in Perseus

Vega - massive blue main sequence star in Lyra

Antares - red giant in Scorpius

Betelgeuse - Orion, Red Supergiant due to explode “soon” 15 solar masses

Rigel - Orion, Blue Supergiant due to explode later, 17 solar masses

Aldebaran - Bright Red Supergiant in Taurus, 2.5 solar masses (WD not SN)

Castor, Rigel - massive blue main sequence stars

Capella, Procyon - on their way to becoming red giants

SS Cygni - brightest dwarf novae in the sky, Cygnus,

U Geminorum - dwarf nova in Gemini

CP Pup, classical nova toward constellation Puppis in 1942

Pup 91, classical nova toward Puppis in 1991

QU Vul, classical nova toward constellation Vulpecula,

GK Per -Perseus, both a classical nova eruption and dwarf nova.

U Sco - Scorpius, recurrent nova

SN 1006 - Lupus/Centaurus (difficult this time of year)

SN 1054 Crab Nebula - Taurus

SN 1572 Tycho - Cassiopeia

SN 1604 Kepler - Ophiuchus

Cassiopeia A - Cassiopeia

Vela supernova - Vela (not this time of year)

Goal - to understand what makes supernovae shine.

Fast explosion of C/O in Type Ia, shock hitting layer of Si in Type Ib, Ic make element closest to iron (same total p + n) with #p = #n

Nickel-56: 28p 28n <u>total 56</u> -- Iron-56: 26p 30n <u>total 56</u>

Ni-56 is unstable to radioactive decay

Nature wants to produce iron at bottom of nuclear "valley"
decay caused by (slow) weak force p $\rightarrow$ n

Nickel -56	γ-rays heat $\rightarrow$	Cobalt-56	γ-rays heat $\rightarrow$	Iron-56
28p	"half-life"	27p	"half-life"	26p
28n	6.1 days	29n	77 d	30n

Secondary heat from γ-rays makes Type I a, b, c shine

Type Ia are brighter than Type Ib and Ic because they produce more nickel-56 in the original explosion.

The thermonuclear burning of C and O in a white dwarf makes about 0.5 - 0.7 solar masses of nickel-56.

A core collapse explosion that blasts the silicon layer makes about 0.1 solar masses of nickel-56.

Type II also produce about 0.1 solar mass of nickel-56, but the explosion energy radiated from the red giant envelope in the plateau tends to be brighter. After the envelope has expanded and dissipated, the remaining radioactive decay is seen.

One Minute Exam

The light from Type Ia supernovae does not come from the heat of the original explosion because:

➡ The supernova must have a size 100 times the Earth's orbit in order to radiate

⬅ Type Ia produce iron in the center

⬆ When carbon burns quickly, nickel is produced

⬇ White dwarfs are very small

One Minute Exam

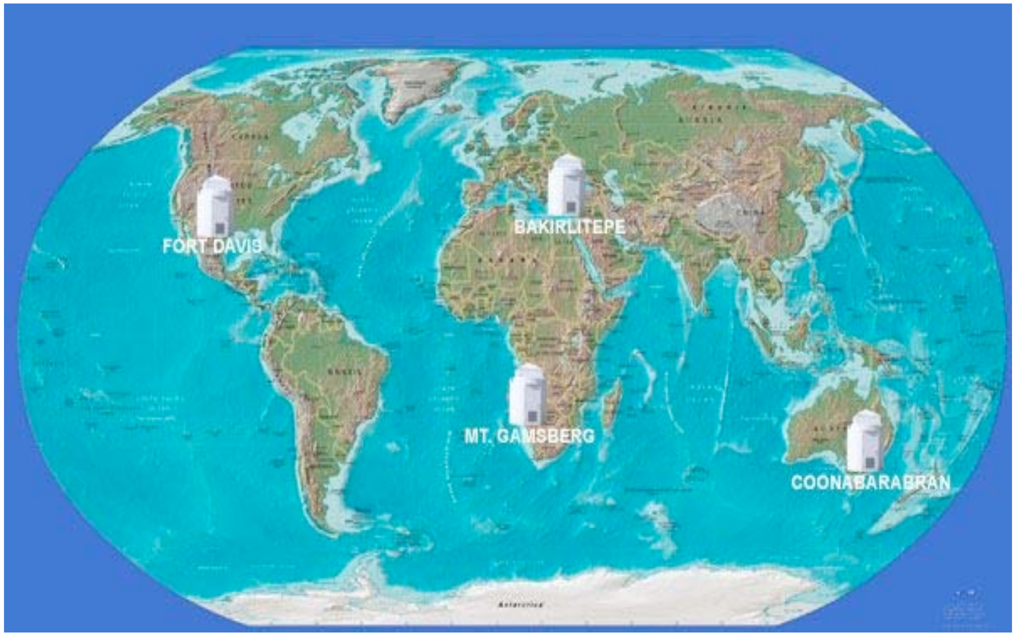
Type Ic supernovae are usually dimmer than Type Ia supernovae because:

- ➡ Type Ic form neutron stars
- ⬅ Type Ic have no hydrogen or helium
- ⬆ Type Ic have binary companions
- ⬇ Type Ic produce less nickle-56

End of Material for Exam 2

Goal – to understand the nature of a new class of super-luminous supernovae

We participate in the U. of Michigan RObotic Transient Source Experiment (ROTSE) collaboration.



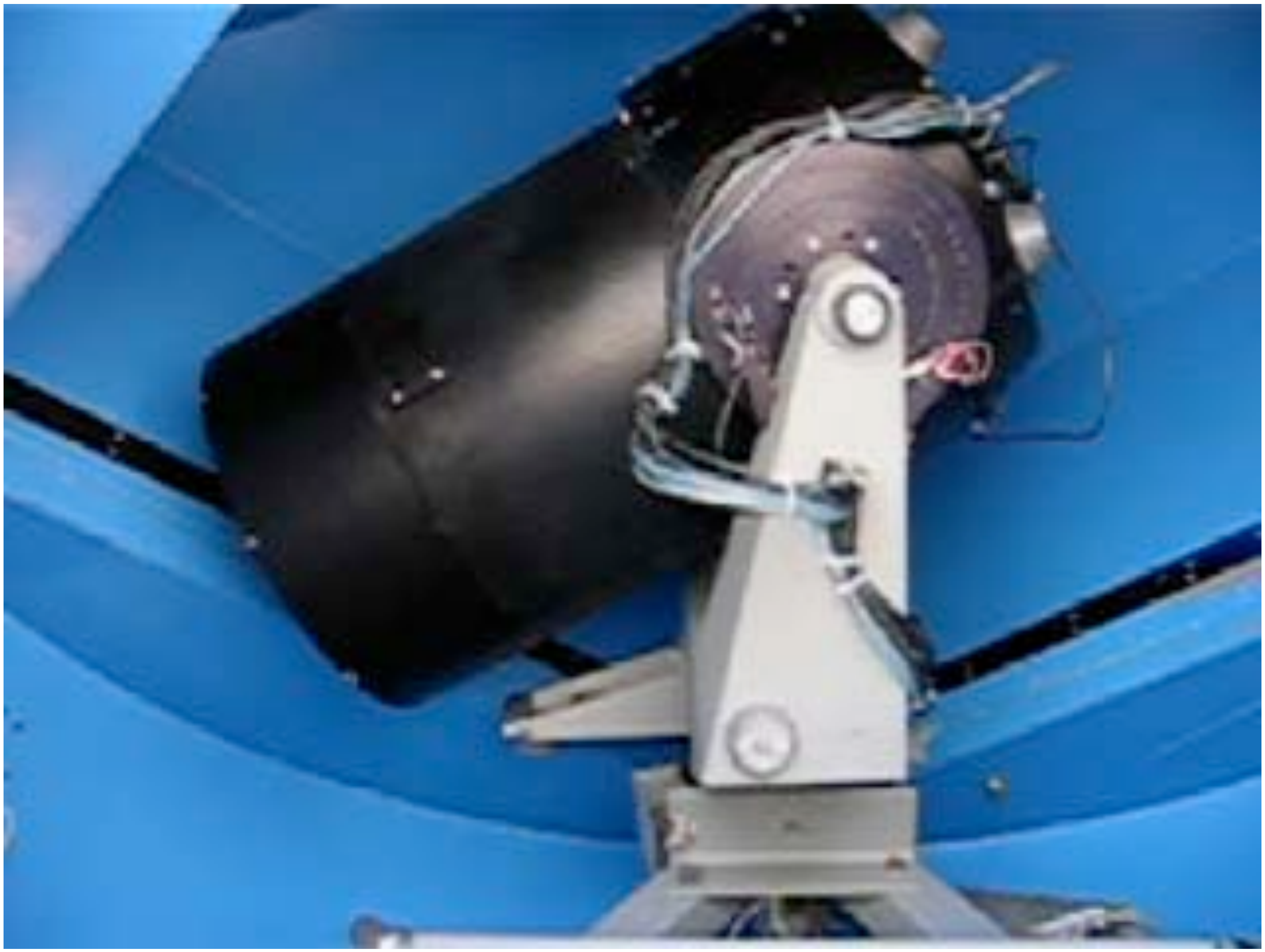
Four ROTSE telescopes around the world. Texas, Australia, Namibia andTurkey.

18 inch mirrors, 1.85 degree squared field of view. Moon is 0.5 degree

ROTSE can point and shoot within 6 secs of electronic satellite notification, take automatic snapshots every 1, 5, 20, 60 secs.

ROTSE has:
Discovered the optical transient ***during*** the 30 second gamma-ray burst;
Followed the light in unprecedented detail;
Relayed the discovery and coordinates to the HET for spectroscopic follow up.

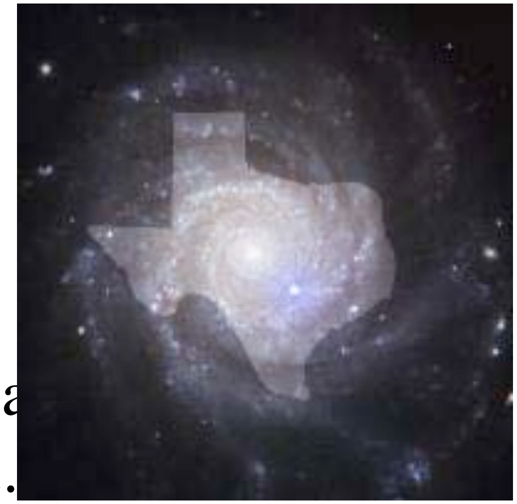
ROTSE IIIb in action



ROTSE3B and Hobby-Eberly Telescopes

The Texas Supernova Search

2004 - Texas graduate student, now Caltech Postdoctoral Fellow, Robert Quimby used ROTSE to conduct the ***Texas Supernova Search***, covering unprecedentedly large volumes of space.



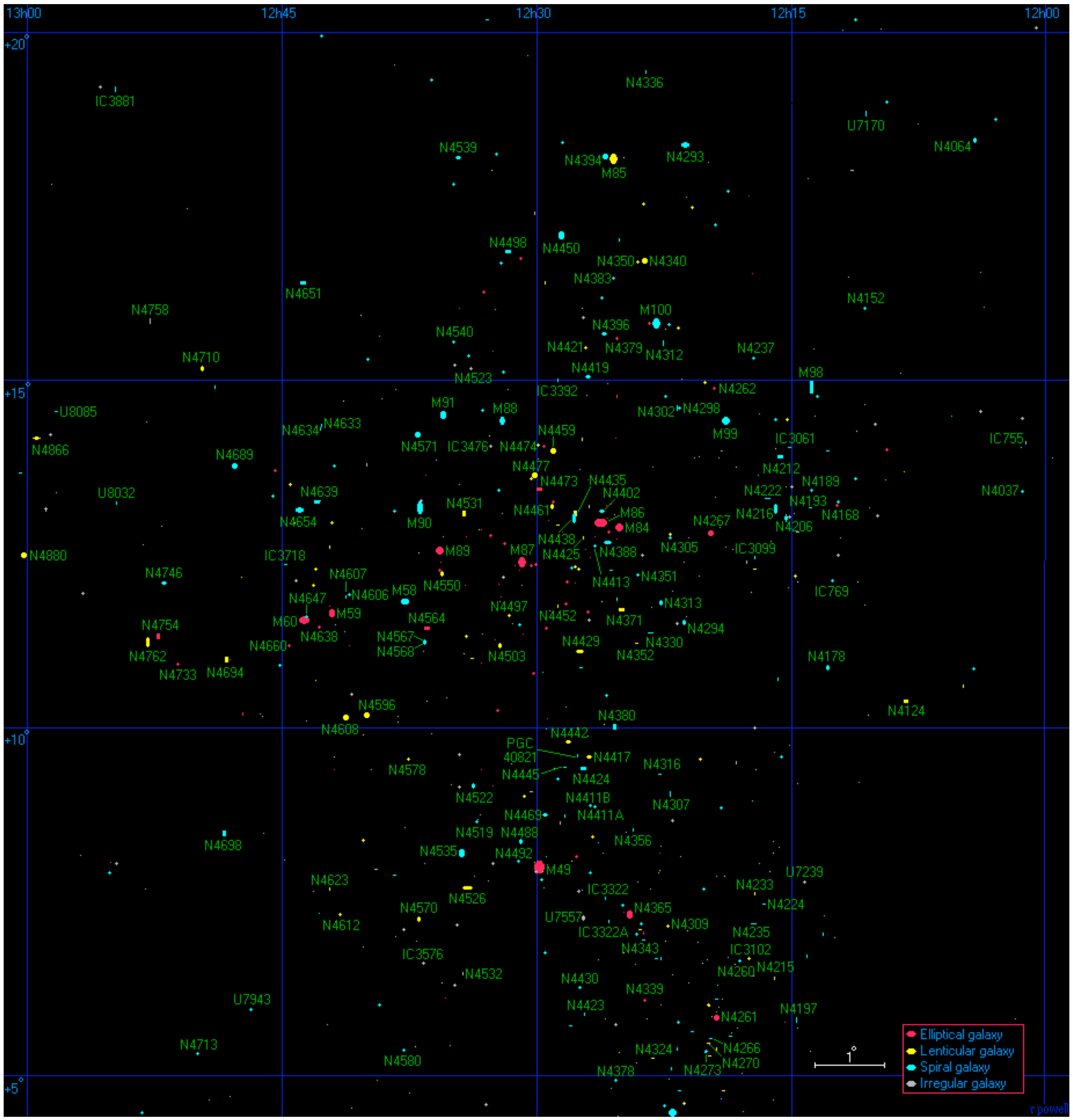
Original (and on-going) goal: search nearby rich clusters of galaxies, Virgo, Leo, Coma, Perseus, Ursa Major, for supernova very early, days, after outburst.

Possible with large field of view, rapid cadence of ROTSE, impossible with small field of view searches that target individual galaxies.

Unbiased search - large galaxies, small galaxies, AGN nuclei, centers as well as outskirts.

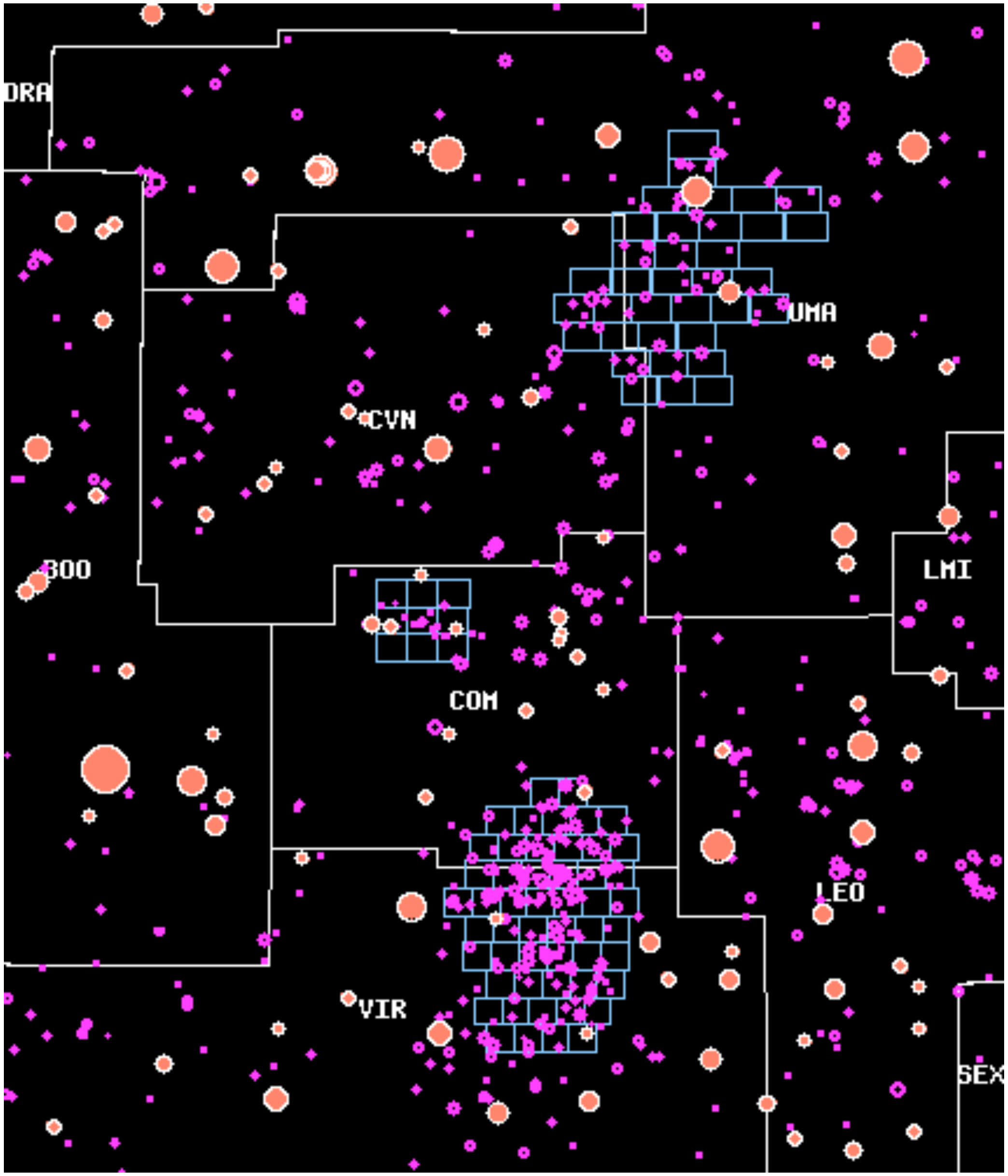
Included vast volume of space, ~10^9 Mpc^3 behind target clusters in ~5 years.

The Virgo Cluster of Galaxies



Too many galaxies to target efficiently one at a time. ROTSE can do it all in about 40 snapshots

The Texas Supernova Search Fields



ROTSE sees many galaxies at once, all the cluster galaxies in about 40 exposures and all the space behind them.

For Sky Watch

Find Virgo, Leo, Coma, Perseus, Ursa Major clusters of galaxies.

A New Type of Supernova

By far the most dramatic discovery by Robert Quimby and the Texas Supernova Search was a whole new class of “super-luminous” supernovae, of order 10 to 100 times brighter than the classical types.

SN 2005ap

SN 2006gy

SN 2006tf

SN 2008es

SN 2008am (Manos working on this now)