Large Area Surveys

ROYAL OBSERVATORY EDINBURGH

- Survey Science
- Discovery Space
- Next Steps

Survey Science

Two modes of science

- Targeted
  - specific scientific question
  - conduct experiment to answer that question
  - make only the necessary measurements
- Survey
  - pre-collect data : summarise sky
  - the archive becomes the sky
  - science done with the archive (VO etc)

Survey advantages

- cost effective
  - many experiments from same data
- supports other experiments
  - create samples to observe elsewhere (follow-up)
  - match with observations made elsewhere (follow-down ?)
- produces surprises
  - first looks in new corners of parameter space
  - new populations

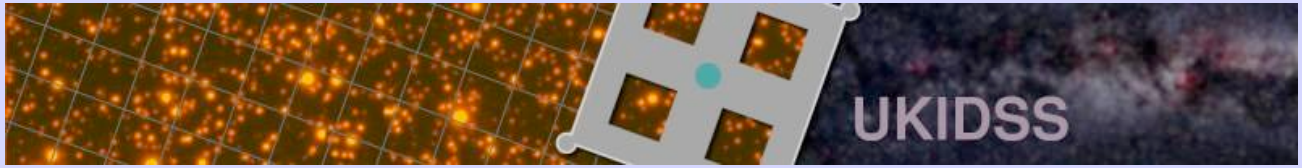
Large area advantages

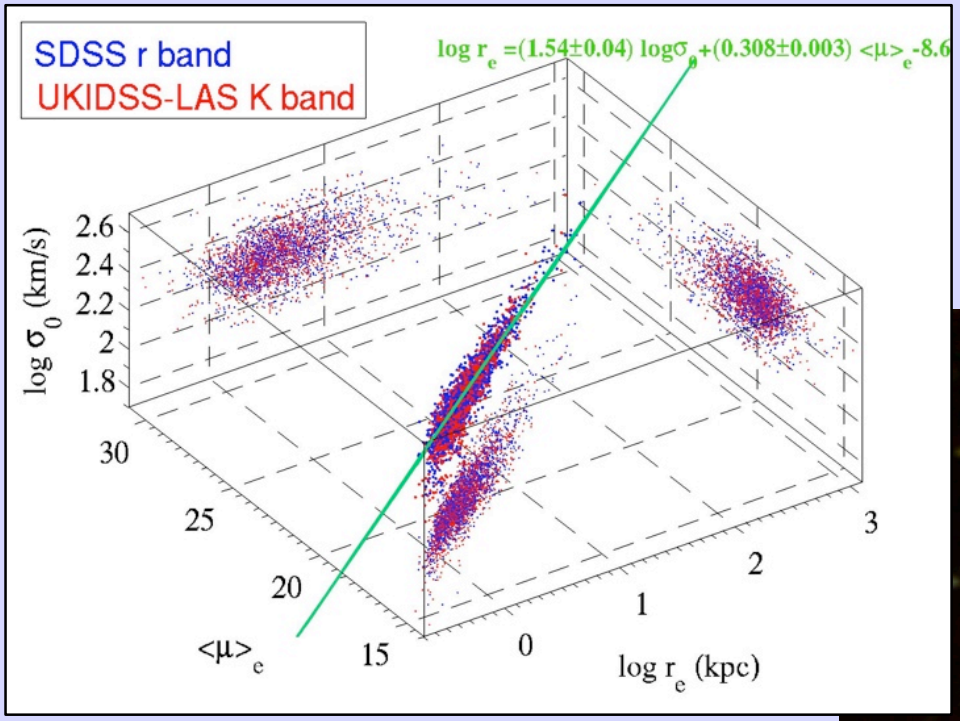
- statistics : large samples
  - accurate function estimation : eg galaxy power spectrum
  - weak signal recovery : e.g. grav lensing
  - wider always faster than deeper
- large structures
  - eg Clusters, Milky Way, Dipole
- rare objects
  - eg Y dwarfs, z=7 quasars

Rich Heritage

- Radio : 3C, 4C ...
- IR : IRAS, 2MASS, UKIDSS
- Optical : APM, SuperCOSMOS, SDSS
- X-ray : Ariel-V, XMM
- Z-surveys PSC-z, 2dFGRS, SDSS-z

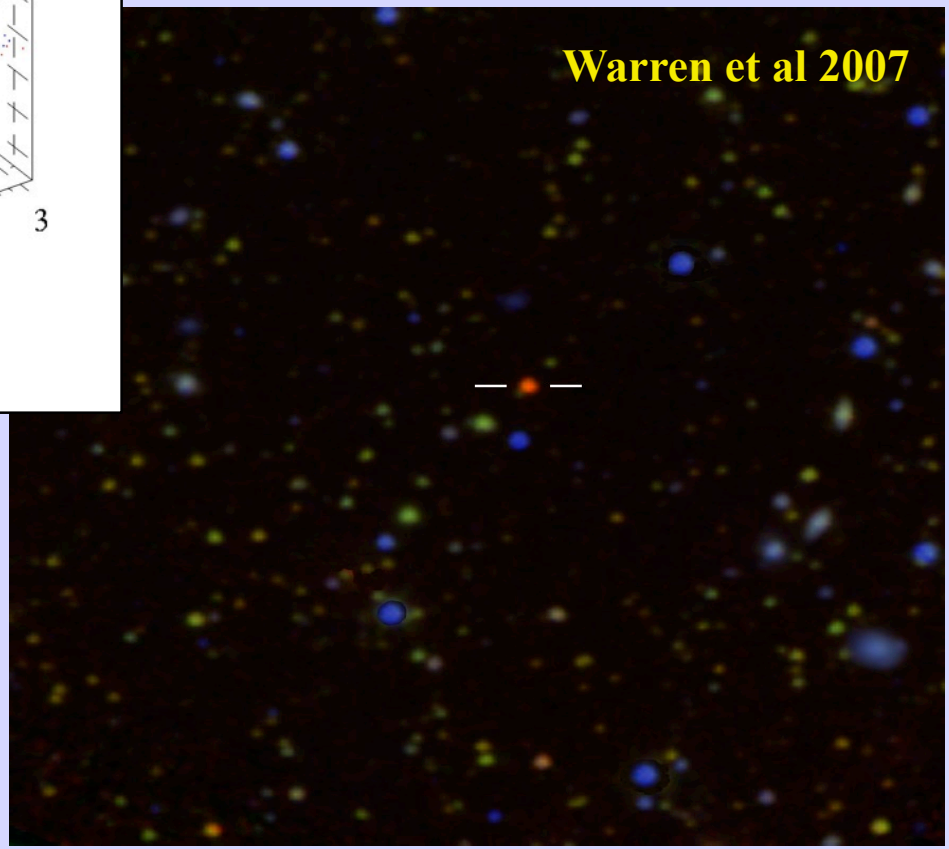
the core of modern astronomy





La Barbera et al 2008

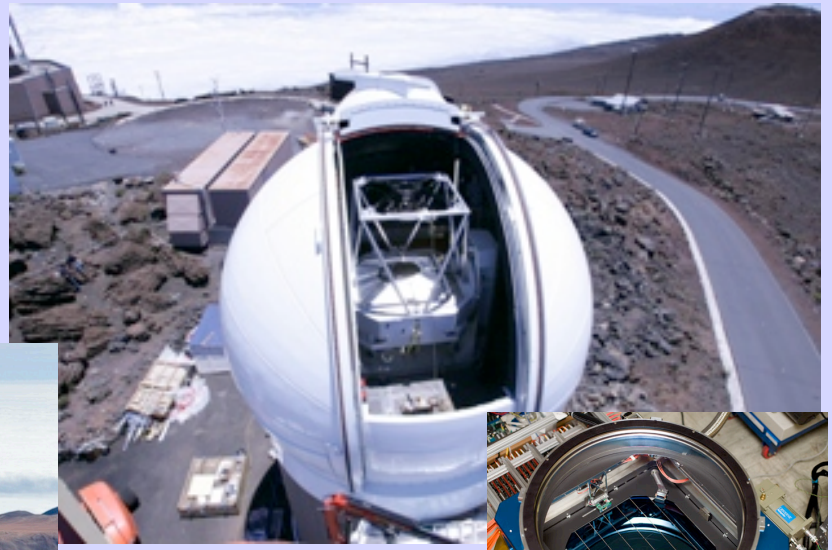
Tilt of FP same in IR and optical : not due to stellar population changes



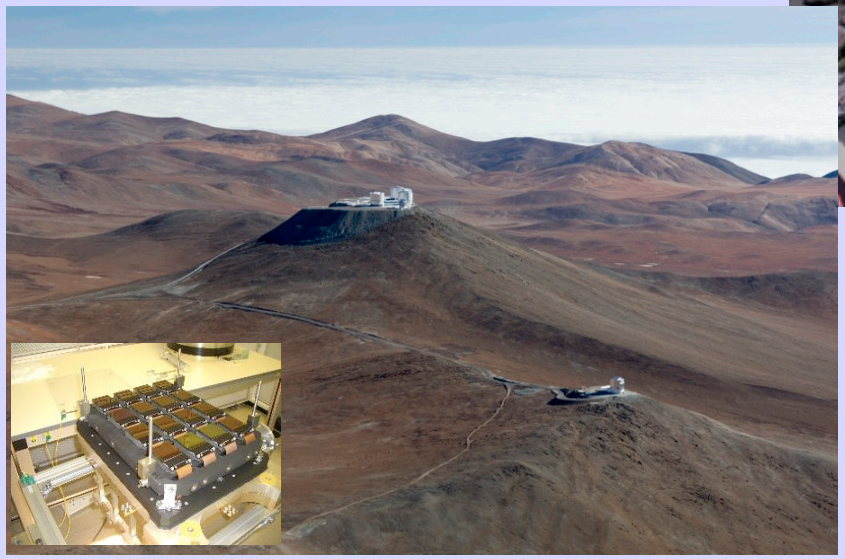
Coldest known star (for a while..)
T=675K D=14pc

New surveys

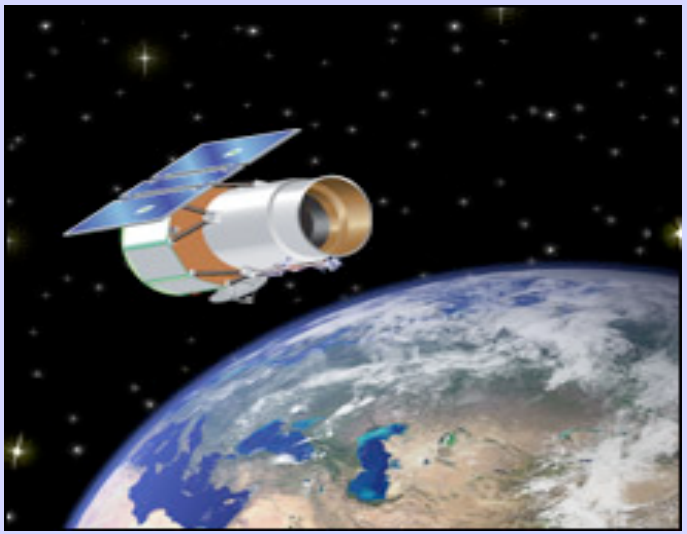
Optical : PanSTARRS-1



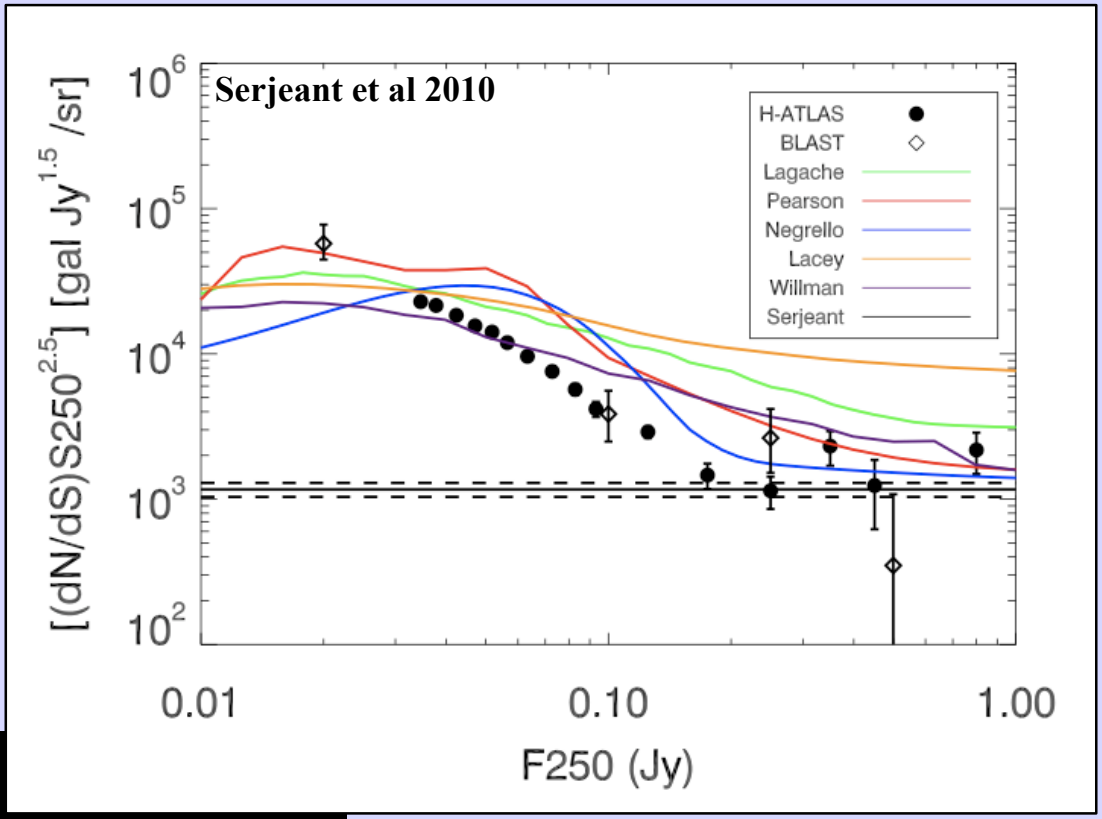
Near-IR : VISTA



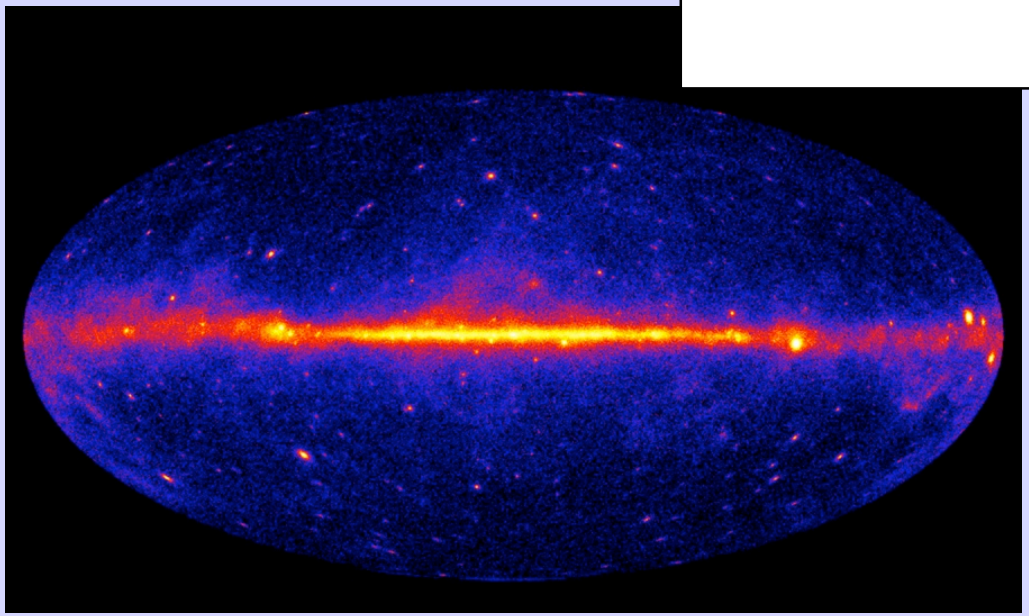
Mid-IR : WISE



New surveys



Gamma-ray: Fermi

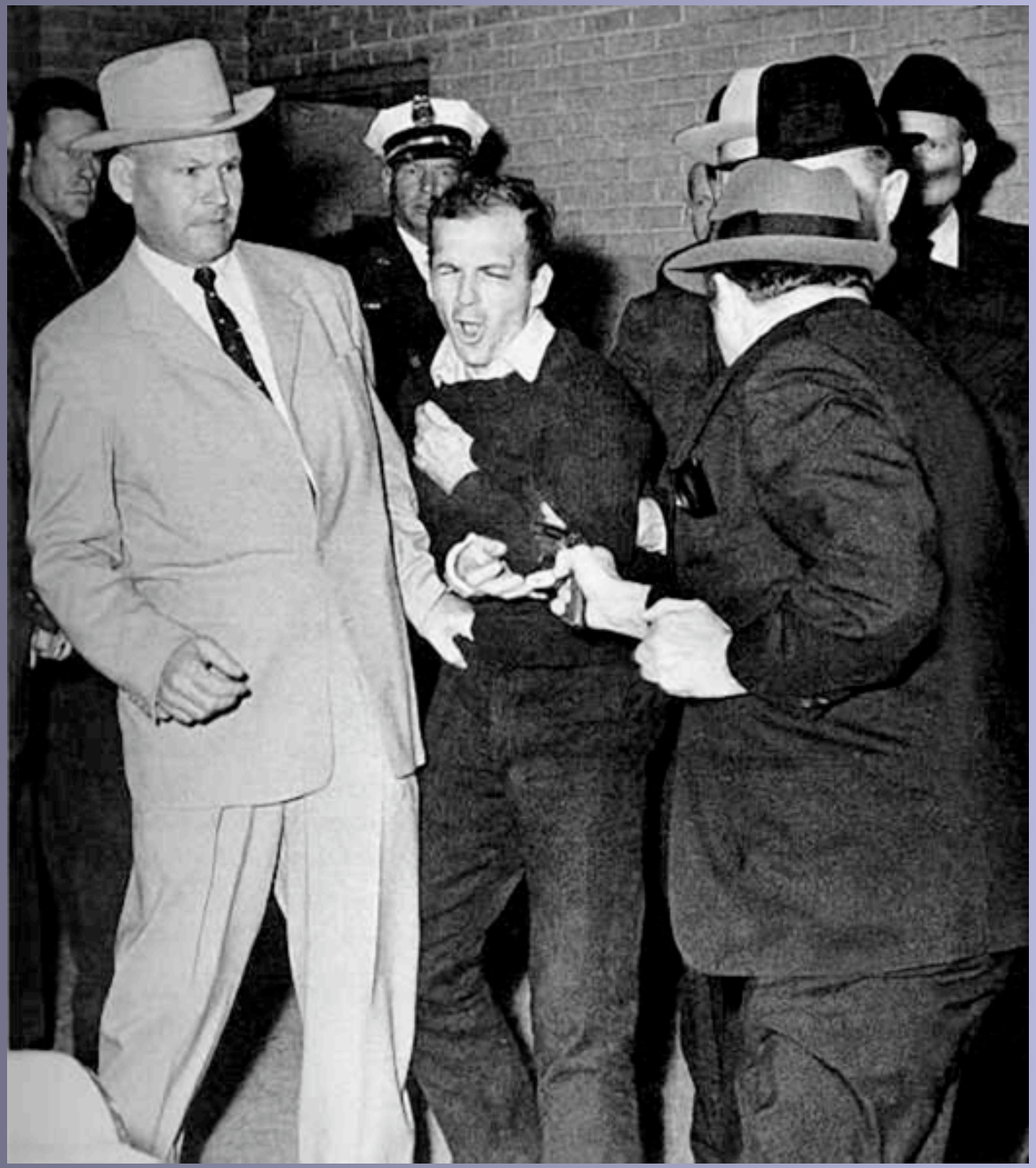


Submm: Herschel-ATLAS

Interlude : CIA conspiracy theories

Suspicious events

- 1962 : British Satellite destroyed by US military ?
- 1963 : Kennedy assassinated by lone gunman
  - yeah, right
- 1963 : First episode of Dr Who
- 1967 : ESRO-2 scuppered by USAF rocket
- 1979 : Ariel-6 switched off by Russian radar
- 1979-2010 : Leeds suspiciously don't win anything important



Oswald being shot by Jack Ruby ?

The uncovered truth: Oswald and Ruby in a jam

George Mahlberg (aka Dr Cosmo) 2000

Discovery Space

Twentieth Century : the universe revealed

- radio : pulsars, quasars
- μwave : cosmic bgnd, molec clouds
- IR : ultraluminous galaxies, brown dwarfs
- X-ray : black holes, intra-cluster medium
- submm : galaxy formation with a bang

...any windows left ?

Discovery Space

• wavelength	done
• photon flux	too expensive
• polzn	targeted obs but not survey
• spec. resoln	too expensive
• time	current big thing
• spatial resoln	next big thing ?
• non-light channels	particles
	gravitational waves

Non-light channels

- gravitational waves, dark matter searches
  - very important for physics
  - but not becoming astrophysics ... (sources, location)
- cosmic rays
  - historically important but now just one big physics question ?
- neutrinos
  - potentially important new signal
  - ICE CUBE and KM3NET may see sources
  - but already hitting funding wall

Next steps

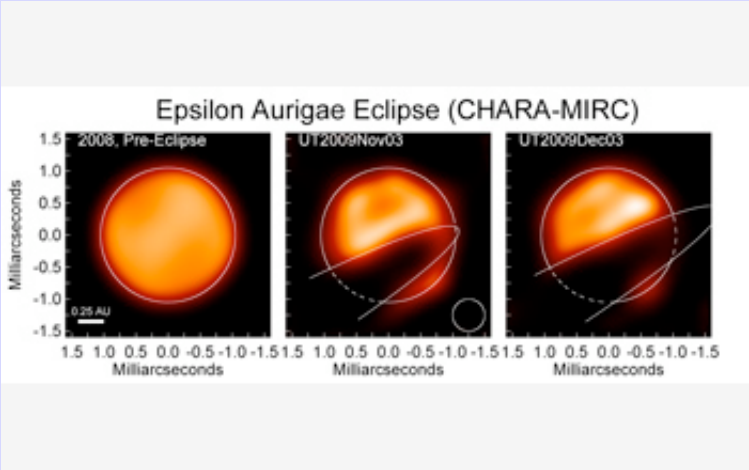
Polarisation

dunno really

sharper is better

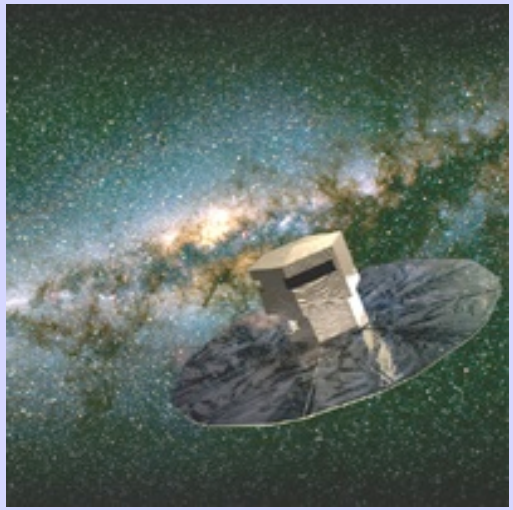
- ground-based OIR interferometers
- space-based OIR interferometers
- X-ray interferometers

all have tremendous potential
but not really survey mode



space astrometry

Gaia



- GAIA : 2012
- centroiding to 10μas
- everything moves

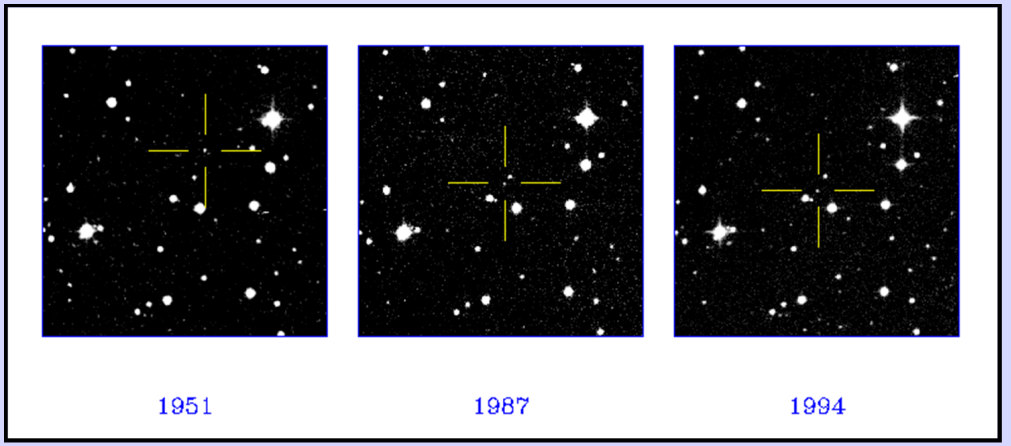
==> the Galaxy in 3D
==> watch external galaxies rotating

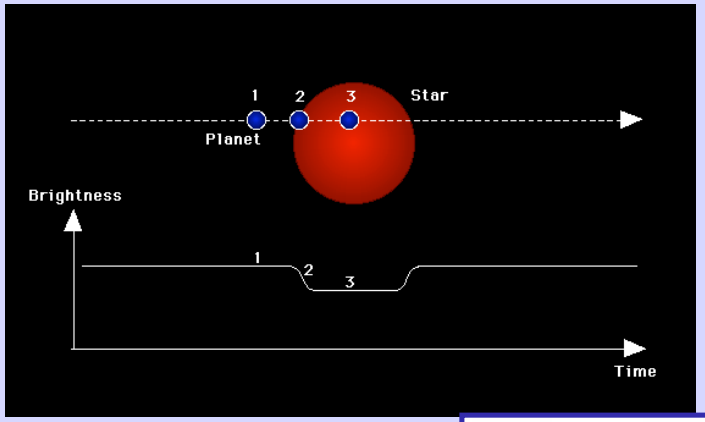
Ch-ch-ch-changes

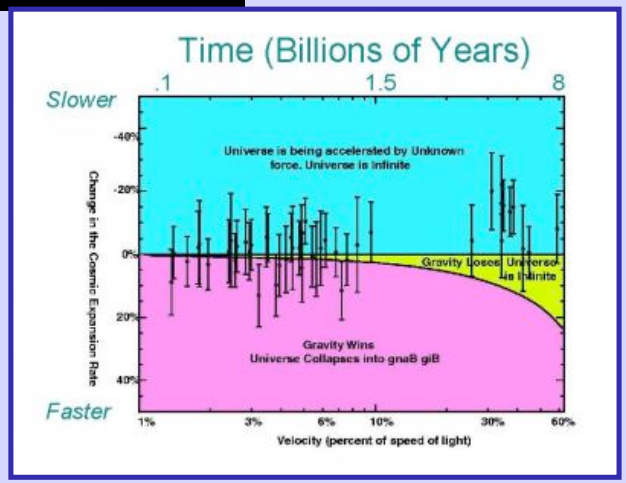
- Historically crucial
  - Keplers laws, X-ray binaries, etc
- New approach is massive monitoring
- Recent past
  - OGLE, MACHO
- Current
  - WASP, Kepler, Corot, PS1
- Future
  - LSST, PS4
  - Lobster ? EXIST ?

science areas

- slow motions
  - substellar objects
  - Near Earth Objects
- periodic changes
  - exoplanet hunts
- transient events
  - high-z supernovae ==> vacuum energy
  - gamma-ray bursts
  - microlensing from MACHOs
  - tidal disruption events

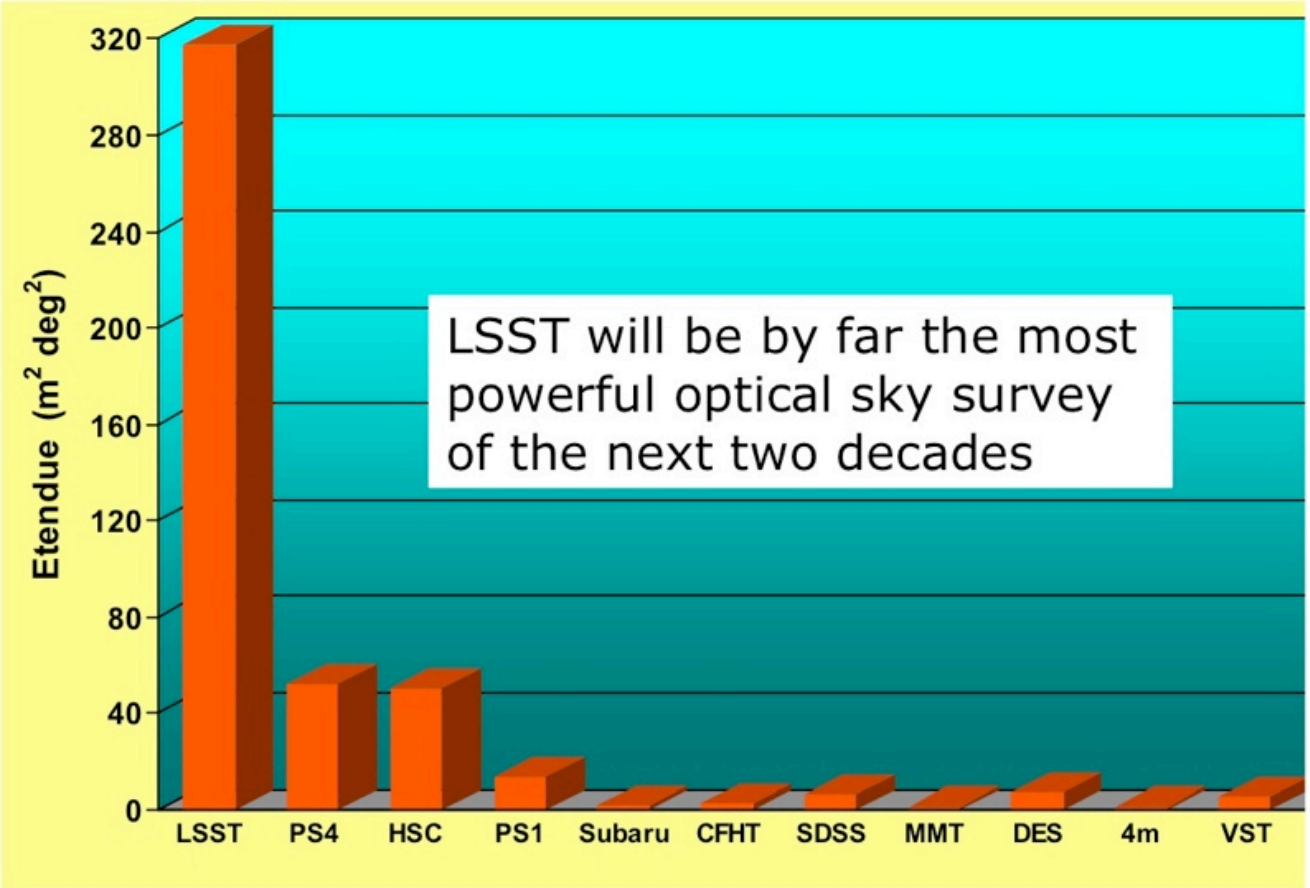






LSST

10,000 sq.deg. every three nights



Orbits for
100,000 NEOs

250,000 SNe/yr

Light curves for
2 million quasars

Proper motions
four mags
deeper than Gaia

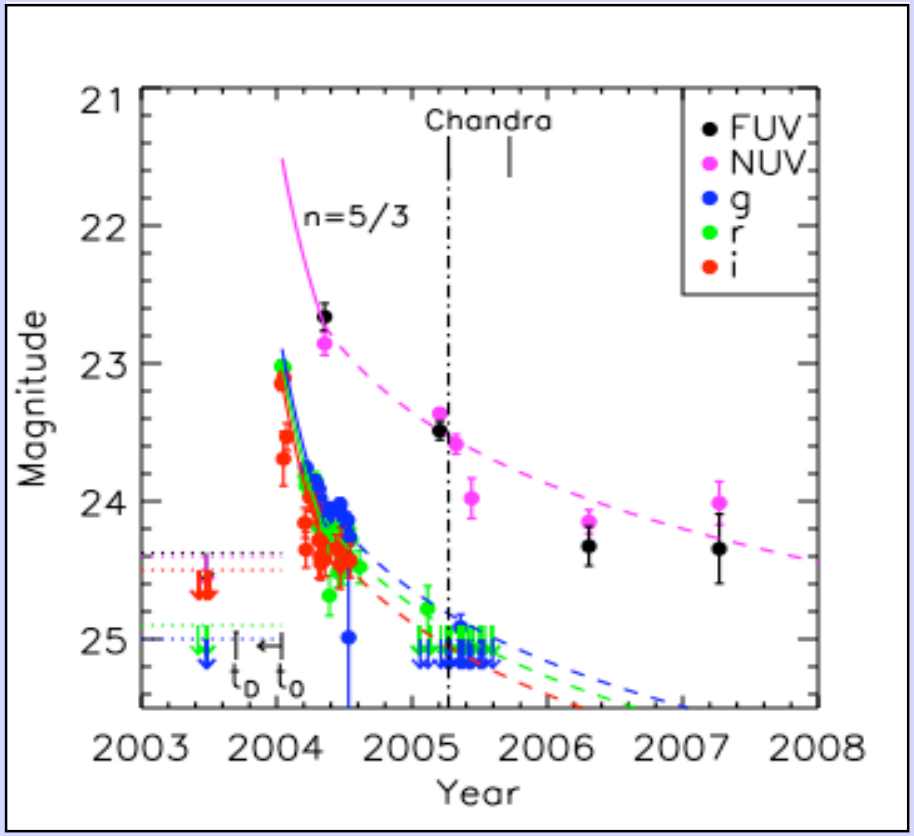
Dark matter map

Tidal Disruption Events

- quiescent SMBH brought to life by passing star
- theory predicts UV/soft-X peak and characteristic $t^{-5/3}$ light curve shape

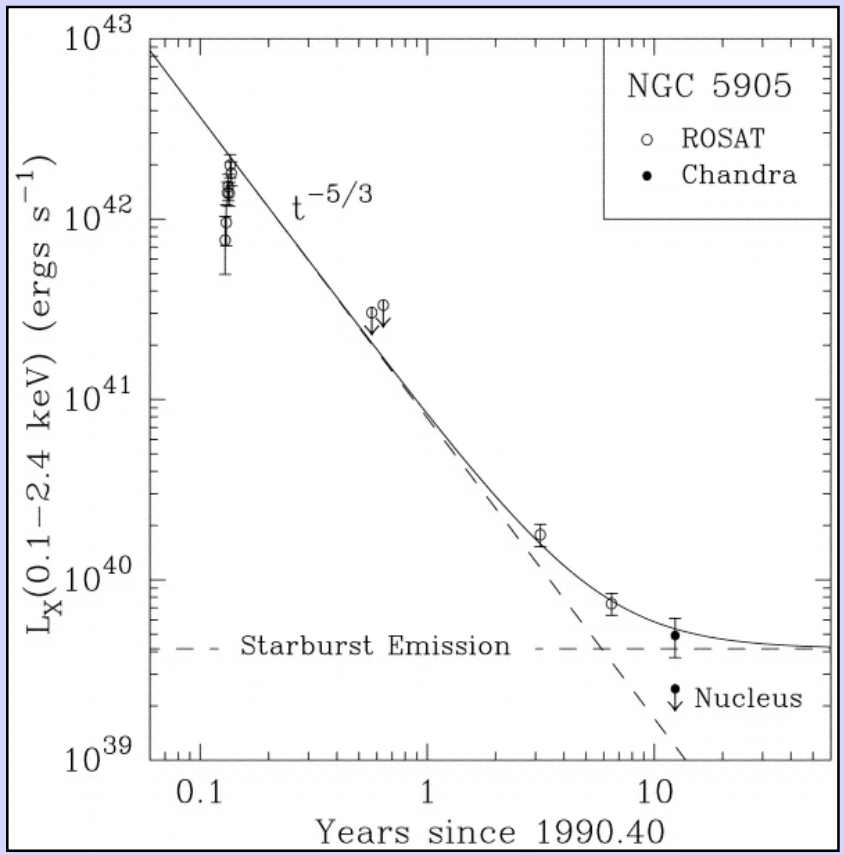
- one per galaxy per 10^5 yrs
- tests accretion theory, prevalence of BH, galaxy structure

Detection claims

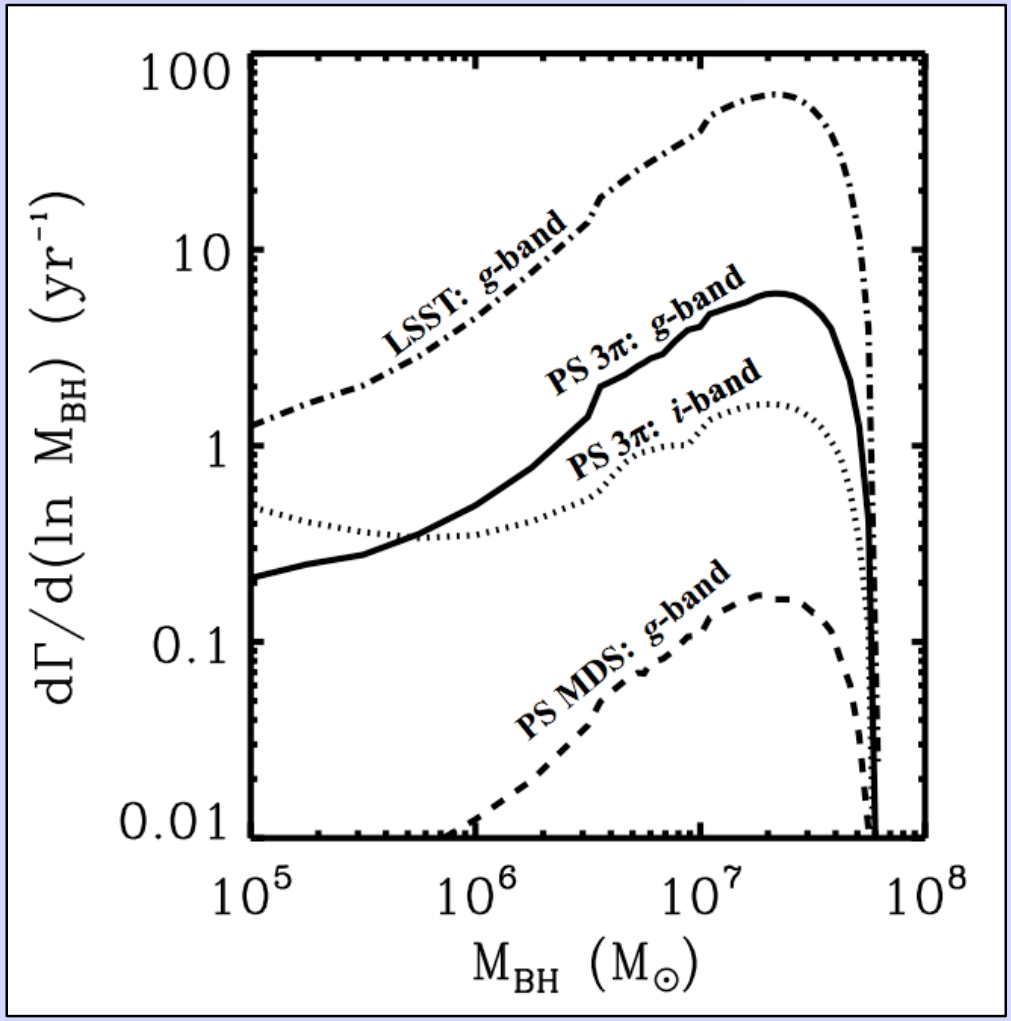


GALEX/Chandra : Gezari et al 2008

ROSAT : Halpern et al 2004



TDE factories



PS1 : 100/yr ?
LSST : 6000 / yr ?

from Bloom et al decadal survey paper

Difficulties

- Rarity
  - for 100 events need to monitor 10^7 galaxies 10 times
  - **all** galaxies to z<0.07 B<19
- Contrast
  - optical : L_{peak} ~0.1 L_{gal}
  - X-ray : L_{peak} ~ 10 L_{gal}
- Pollution
  - optical : SNe 10^3 times more common

All sky soft X-ray monitor please.

FIN