ATACAMA

Guiding Principles

- Scientific Excellence
- Internal Synergy
- Special Niche/Visibility
- Cornell Leadership

We propose:

- A project of scientific excitement and uniqueness, from planets to Cosmology, in the IR/submm niche;
- with focus that emphasizes Cornell's instrument building talent;
- that can sensibly be completed within the decade;
- that will place Cornell in the forefront of research in one of the most rapidly developing observational/ technological fields;
- that will provide Cornell with strong leverage for ALMA access/joint project development;
- of cost that will allow Cornell to lead.
- A development strategy that will place Cornell to advantage on a pathway to a "high altitude observatory".

- A 25m class FIR/submm telescope that will operate with high aperture efficiency down to λ = 200 μ
- With large format bolometer array cameras (FOV>5') and high res heterodyne receiver
- At a high site with PWV<1 mm and wide sky coverage
- NOT confusion-limited with exposures of 24 hrs or less

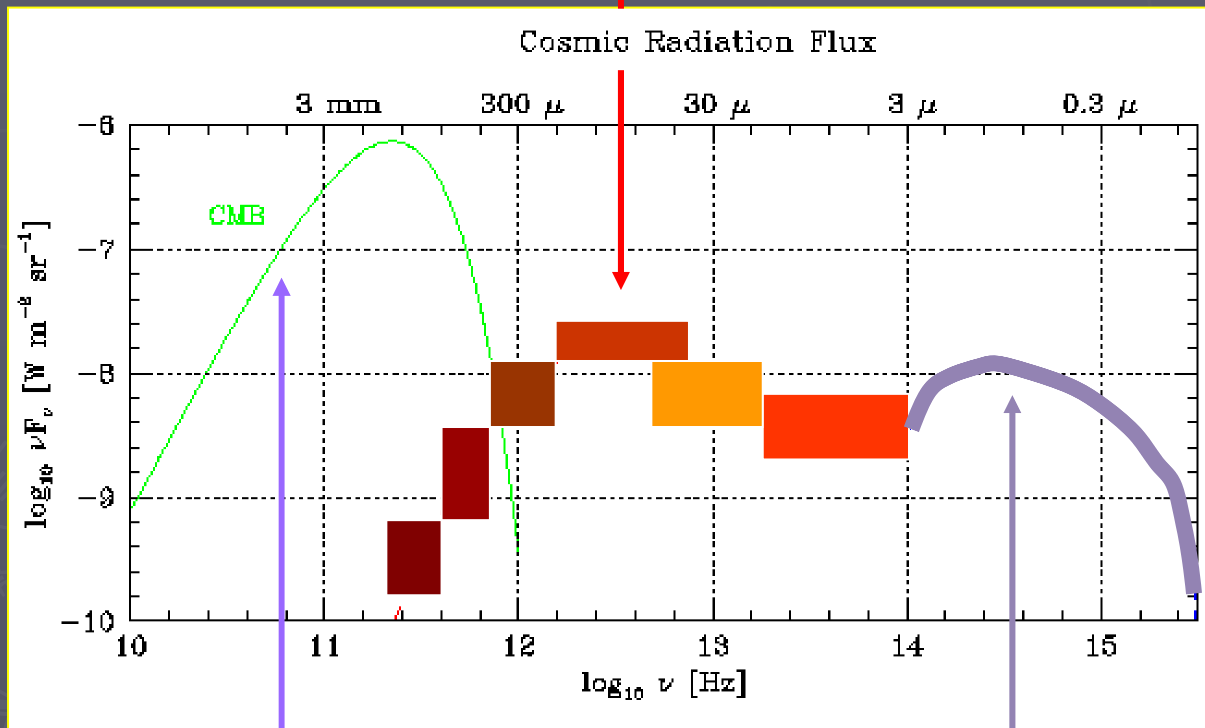
Science Goals:

1. Galaxy Formation & Evolution
2. ISM, Disks, Star & Planet Forming Regions
3. CMB and the SZE
4. Solar System Objects

Let's consider two particularly illustrative cases:

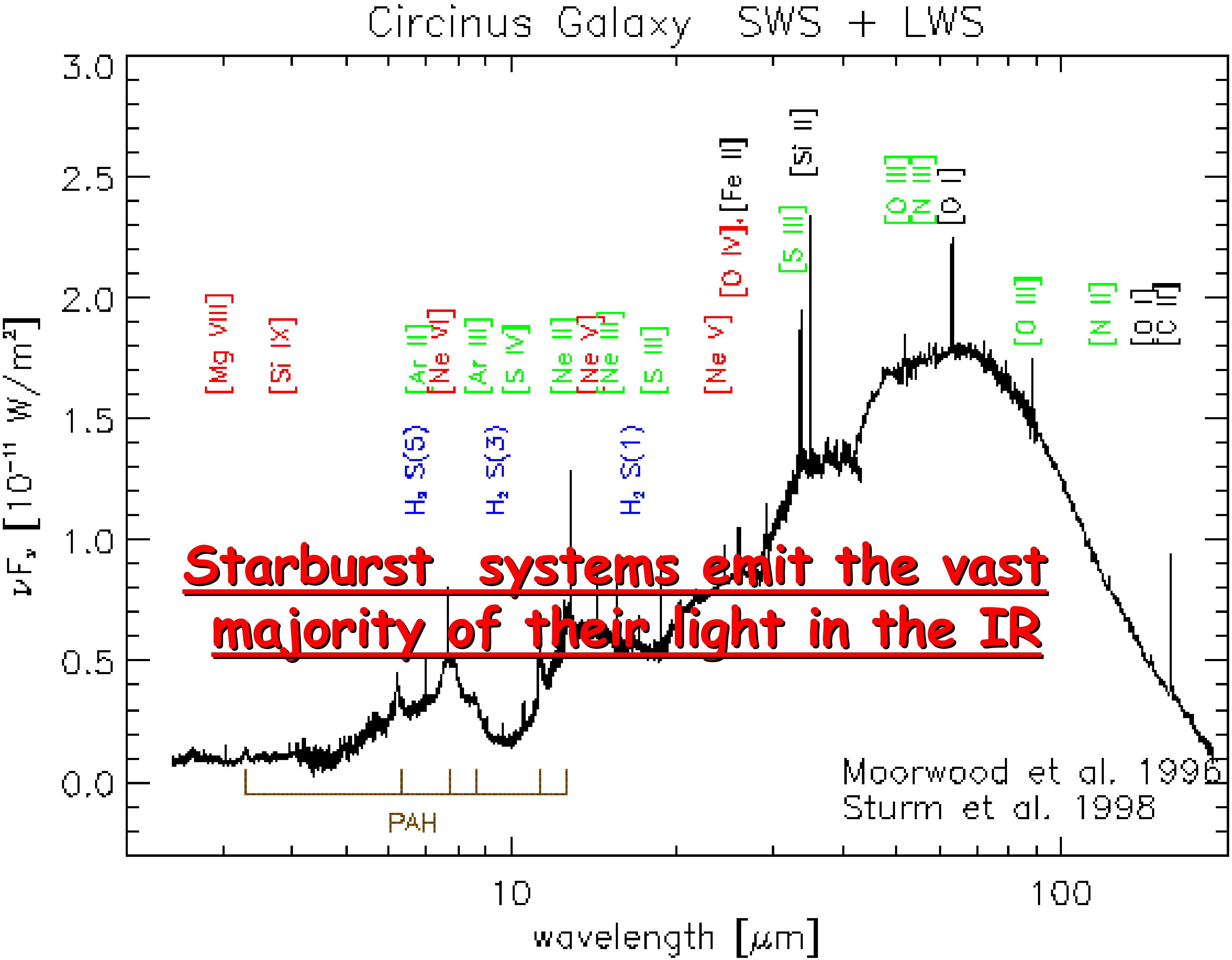
- galaxies in the early Universe
- KBOs and Irregular Satellites in the Solar System

Photospheric light
Reprocessed by dust



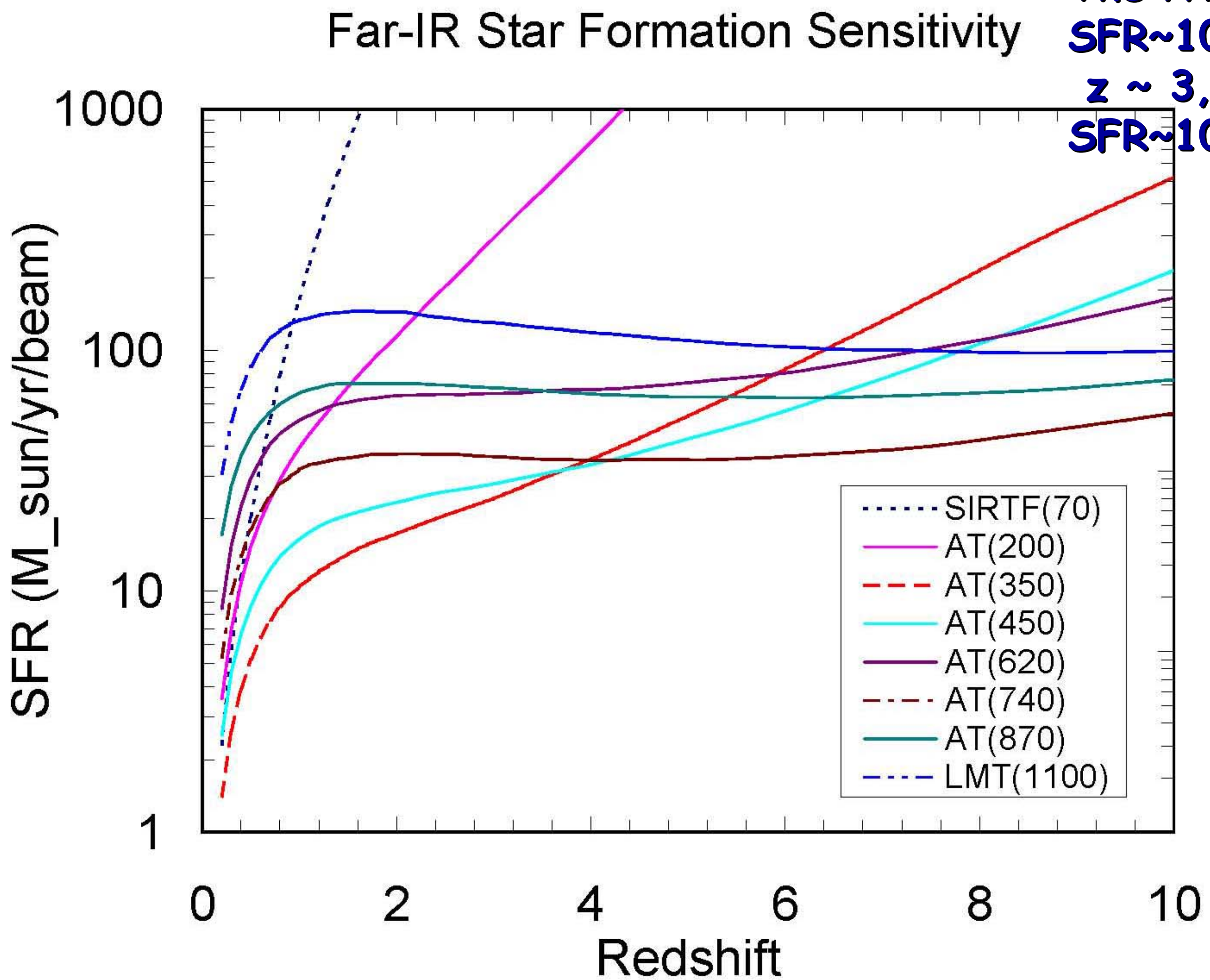
Microwave Background

Photospheric light
from stars



Starburst systems emit the vast majority of their light in the IR

The AT will detect SFR~10-30 up to a z ~ 3, and SFR~100 at all z



AT: 25-m, SNR = 5, t = 10000 sec

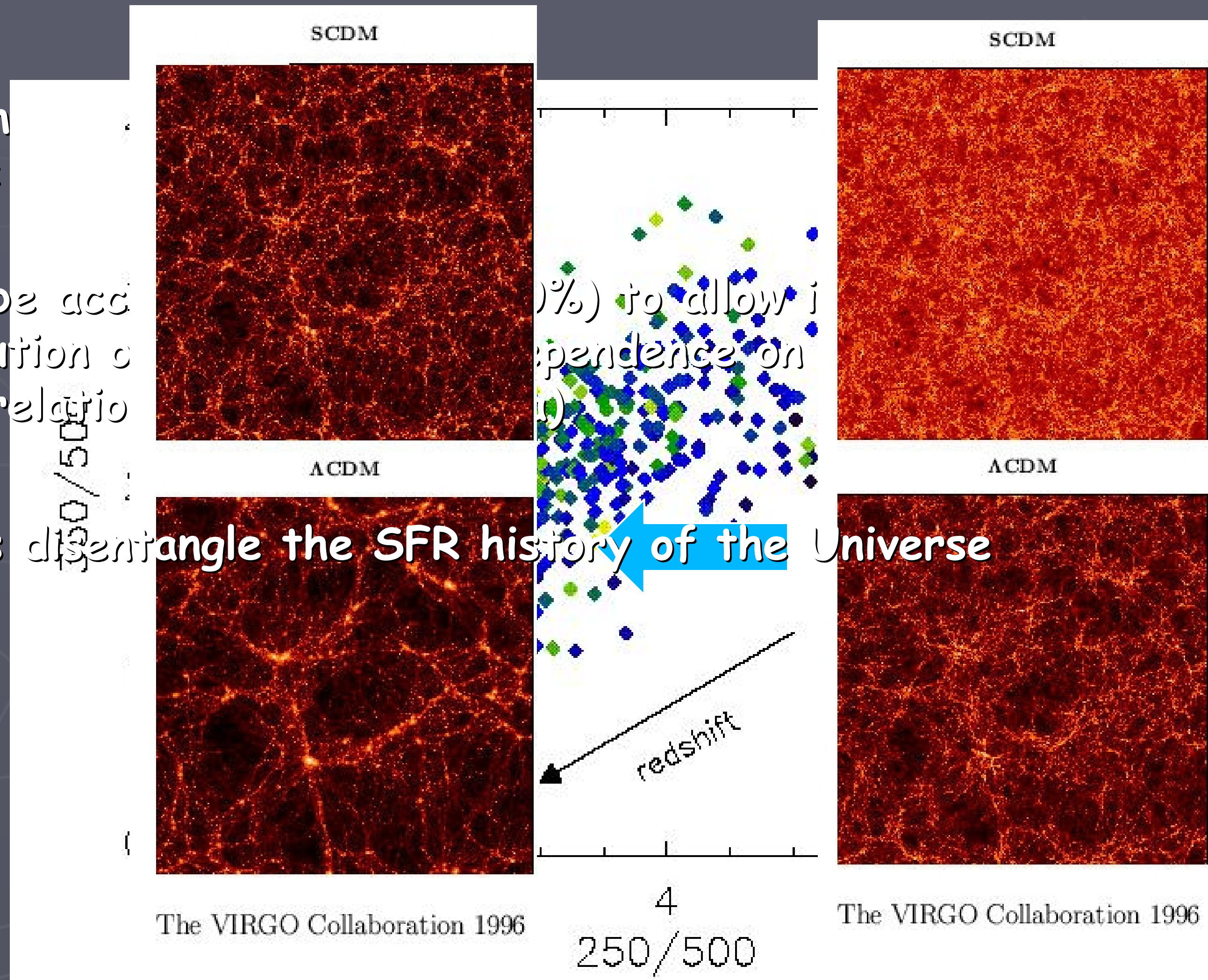
SIRTF, LMT, AT(870): confusion ltd.

A 3000 hr survey with the AT will detect ~ 200,000 galaxies, mostly with z ~ 2-4, but easily up to z ~ 10 (if they exist)

Access to m
photometric

Which will be acc %) to allow i
of the evolution o pendence on
angular correlatio)

… as well as disentangle the SFR history of the Universe



… at z=0

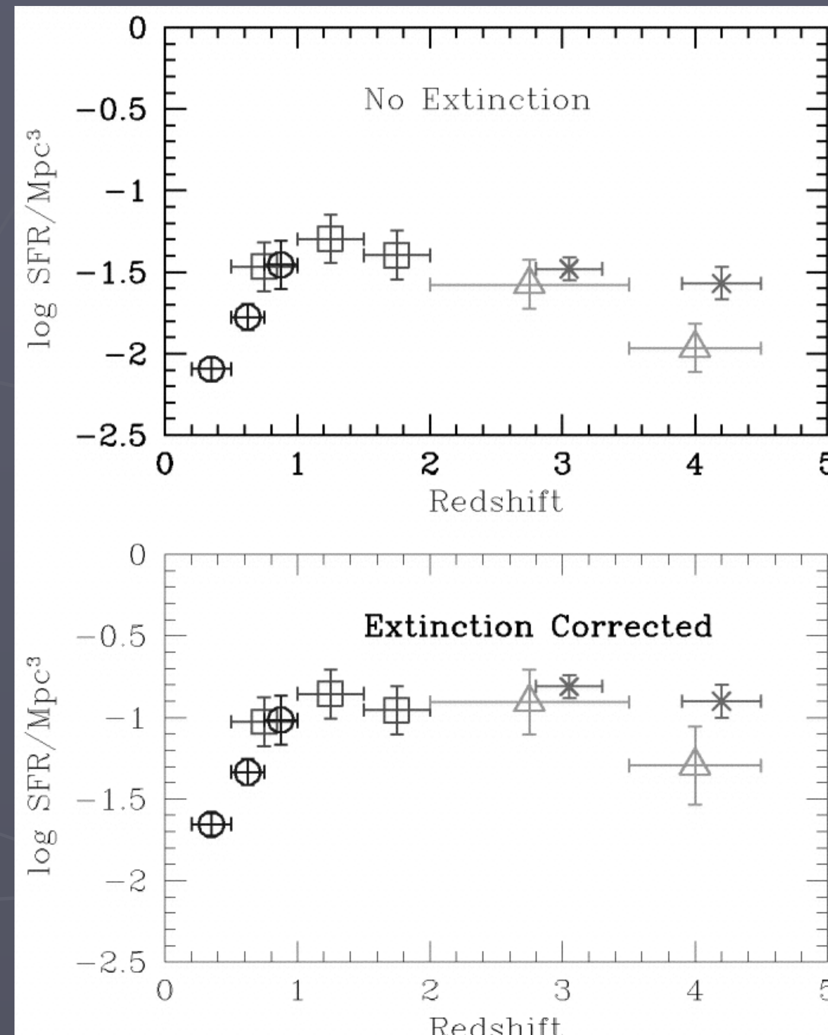
at z=3…?

Star Formation Rate in the Universe

For

$$\Omega_{mass} = 0.3$$
$$\Omega_{\Lambda} = 0.7$$
$$h = 0.67$$

t(z=0) = 14.0 Gyr
t(z=1) = 6.0 Gyr
t(z=2) = 3.4 Gyr
t(z=3) = 2.2 Gyr
t(z=4) = 1.6 Gyr
t(z=5) = 1.2 Gyr after BB



FIR spectroscopy of most of the galaxies detected in the continuum will be detectable also in spectral lines such as [OI] 63 μ, [OIII] 88 μ, [NII] 205 μ and, especially, [CII] 158 μ

[CII] 158 μ will be traceable between z=0.25 and z=4.8, as it gets redshifted across the submm telluric windows.

FIR spectroscopy will allow the study of the physical conditions in the star forming gas, the properties of the interstellar radiation field, as well as the internal dynamics of primeval galaxies and of their merger histories.

In a primeval galaxy survey by the AT, the combination of:

- statistical wealth (nr of detections)
- access to multiple submm bands (photometric z)
- quality of SED determination
- redshift and SFR stretch
- access to fine structure FIR lines
- ability to carry out deep surveys

will be unmatched by those of any existing or currently planned telescope.

As the light of distant galaxies reaches us mainly in te FIR/submm, AT will be prime instrument for study of galaxy formation

Studies of faint Solar System obsjects illustrate well a most important concern for FIR/submm telescopes:

CONFUSION

KBOs: trans-Neptunian objects probably formed early in the Outer reaches of the solar protoplanetary disk.
Several hundreds known; Pluto (D~2400km), Charon (D~1200 km), Varuna (D~900km) are the largest.

Optical/NIR observations yield orbital parms, flux – not size.

At distances of 40-50 AU, KBOs have temperatures near 45 K, emitting most of their radiation in FIR. Pluto, Charon, Varuna & Chaor have been detected at 850 mm by JCMT, yielding sizes and albedos. In the RJ regime, the flux at the wavelength λ is

$$S_{mJy} = 2.7 \times 10^4 D^2 \lambda^{-2} \Delta^{-2.5}$$

where D is the KBO diameter and Δ is its distance

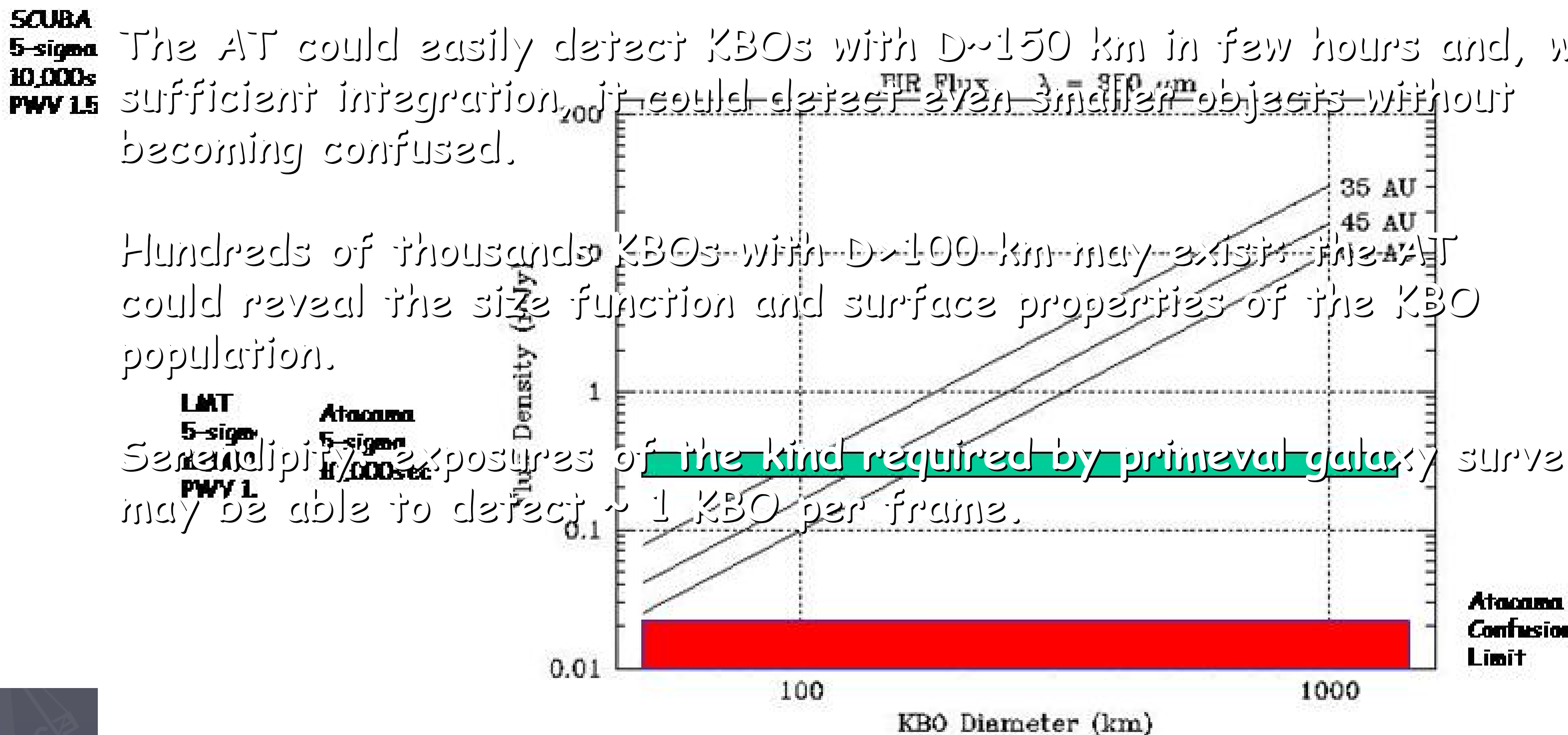
The measurement of S yields the size D and, in combination with optical/NIR measurements of the reflected light, the albedo and estimates of the surface properties.

Problems: sensitivity and confusion

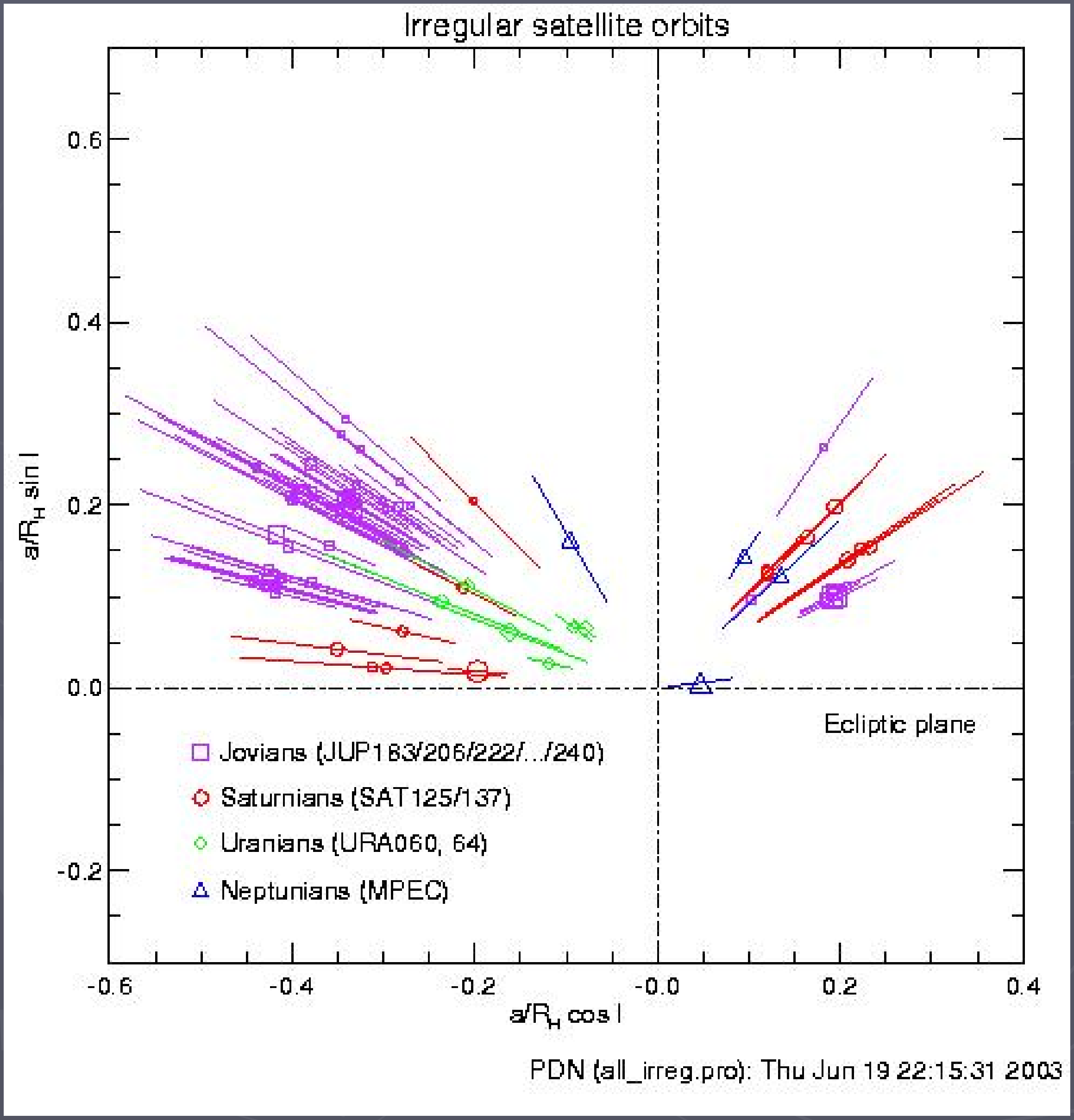
The AT could easily detect KBOs with D~150 km in few hours and, with sufficient integration, it could detect even smaller objects without becoming confused.

Hundreds of thousands KBOs with D>100 km may exist: the AT could reveal the size function and surface properties of the KBO population.

Serendipity: exposures of the kind required by primeval galaxy surveys may be able to detect ~ 1 KBO per frame.



Irregular Satellites



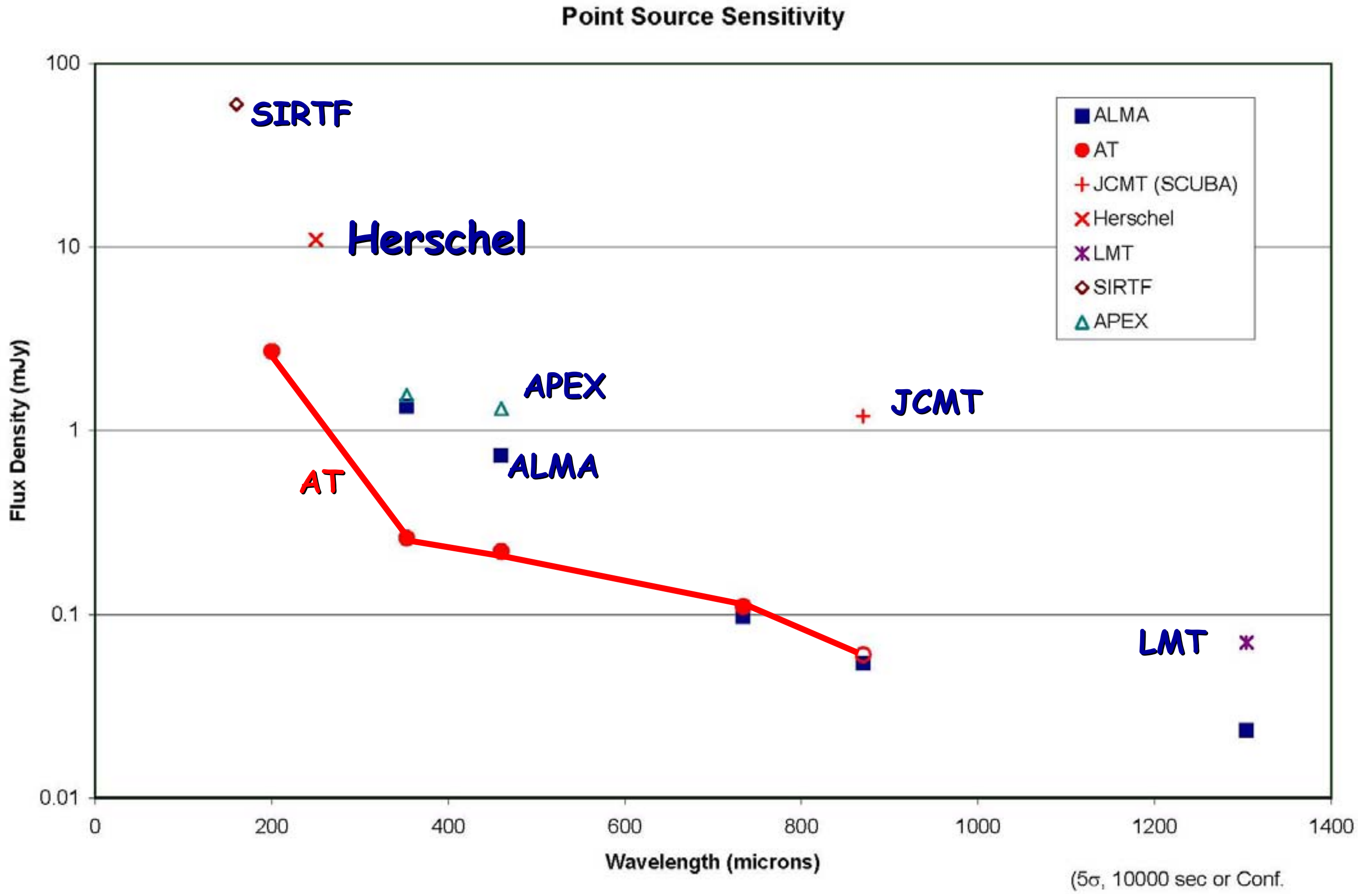
They come in families:
the result of fragmentation?

Sizes measurable to few km
➔ albedos

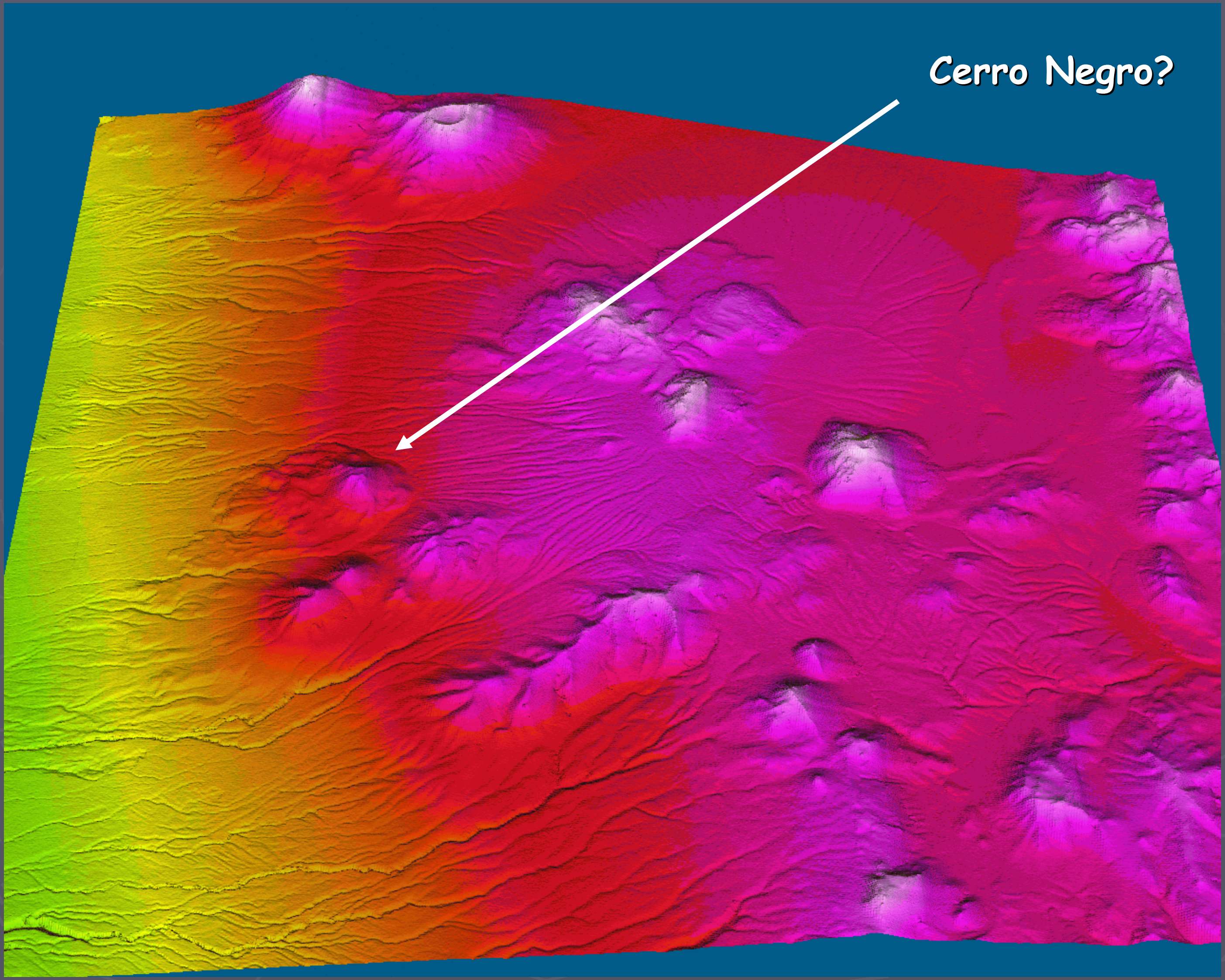
If fragments of originally single object
➔ same albedo in each family

Comparisons and Synergies

1.
2.
3.
4.
5.
6.
7.



Site



… more later on this

Instrumentation

1. 10K bolometer array operating at 350 and 450 μm (*)
2. 10K bolometer array operating at 620 and 850 mm
3. R=1000, 4x256 grating spectrometer
4. 10K bolometer array operating at 200 mm
5. High spectral res heterodyne system

(*) operating at first light