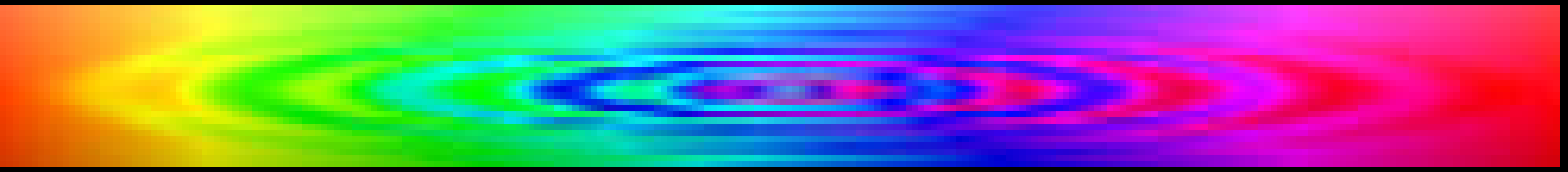


J. Devriendt
CRAL Observatoire de Lyon

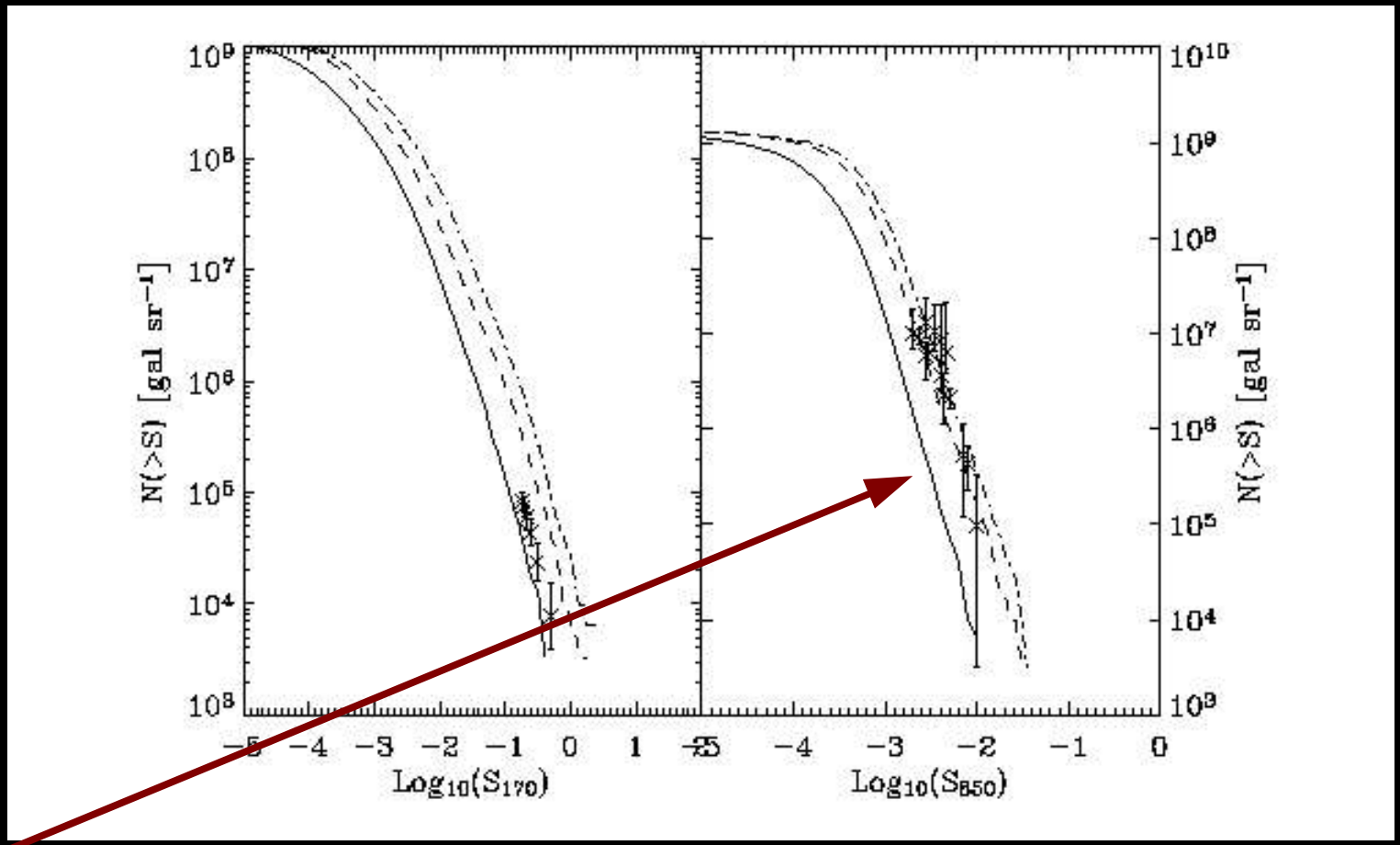
with: C. Balland (IAS, Orsay)
& J. Silk (Oxford)

Moriond, 8 March 2005

Outlook

- The IR problem(s) and solution(s)
- A simple ab- initio analytical approach to galaxy formation (very brief)
- The collision model
- Results: from galaxy counts and redshift distributions to the cosmic star formation history ...
- Conclusions and future prospects

THE(far)IR/submm problem

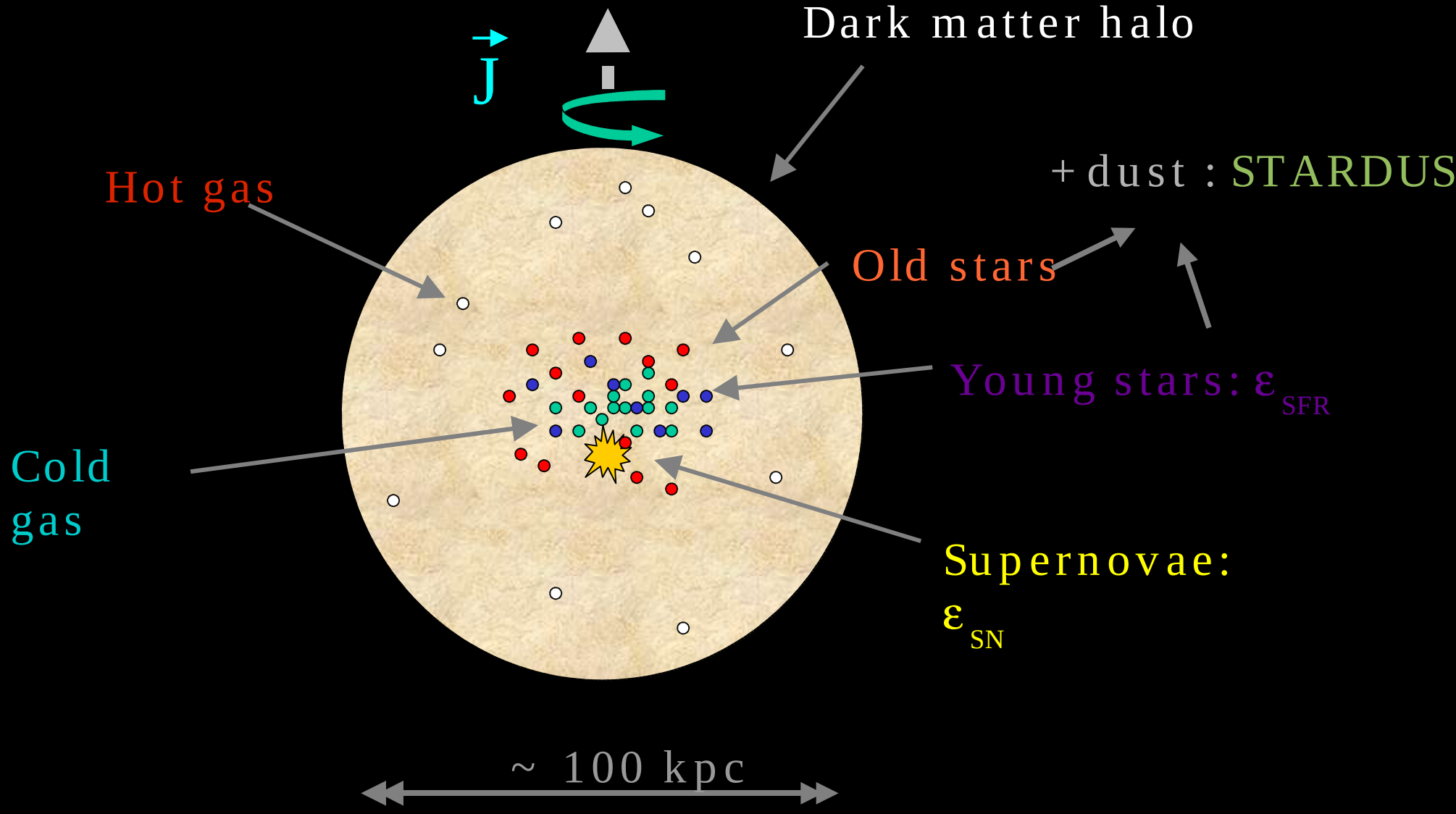


Generic scuba submm counts predictions from classic SAM: 2 possibilities (+ combinations): - i/ number density off by a factor 10 - ii/ flux of each source is underestimated by a factor 3

Galaxy properties from SAMs

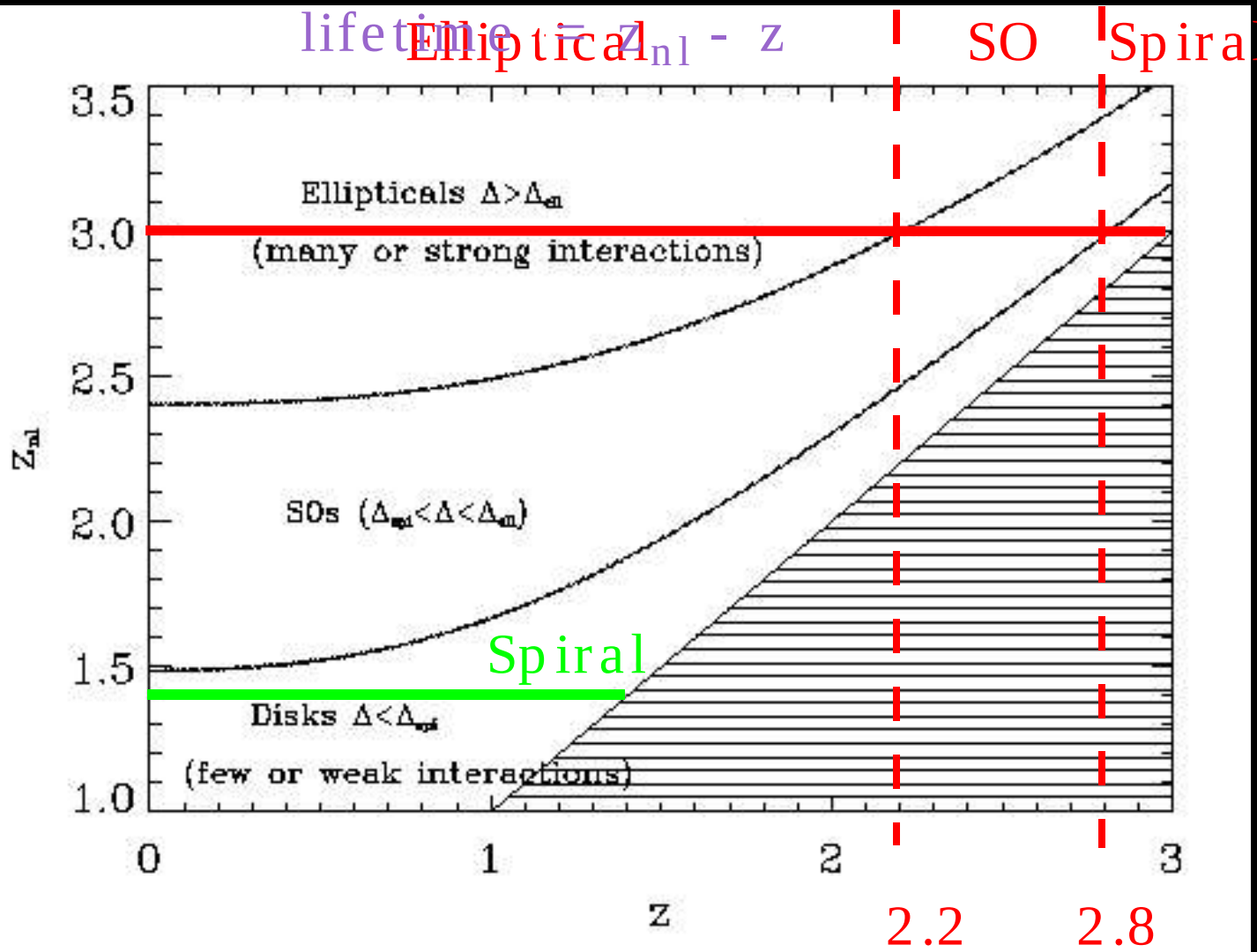
- Using the EPS formalism and Top Hat model to predict the number density evolution of dark matter halos from the primordial power spectrum of dark matter density fluctuations ($\Omega_o = 0.3$; $\Omega_\Lambda = 0.7$; $h = 0.65$; $\sigma_8 = 0.86$; $n = 1$)
- From halos to galaxies with a simple semi-analytic models: minimal number of free parameters for the baryon physics ($\Omega_B =$

Typical picture of a spiral galaxy in a simple SAM



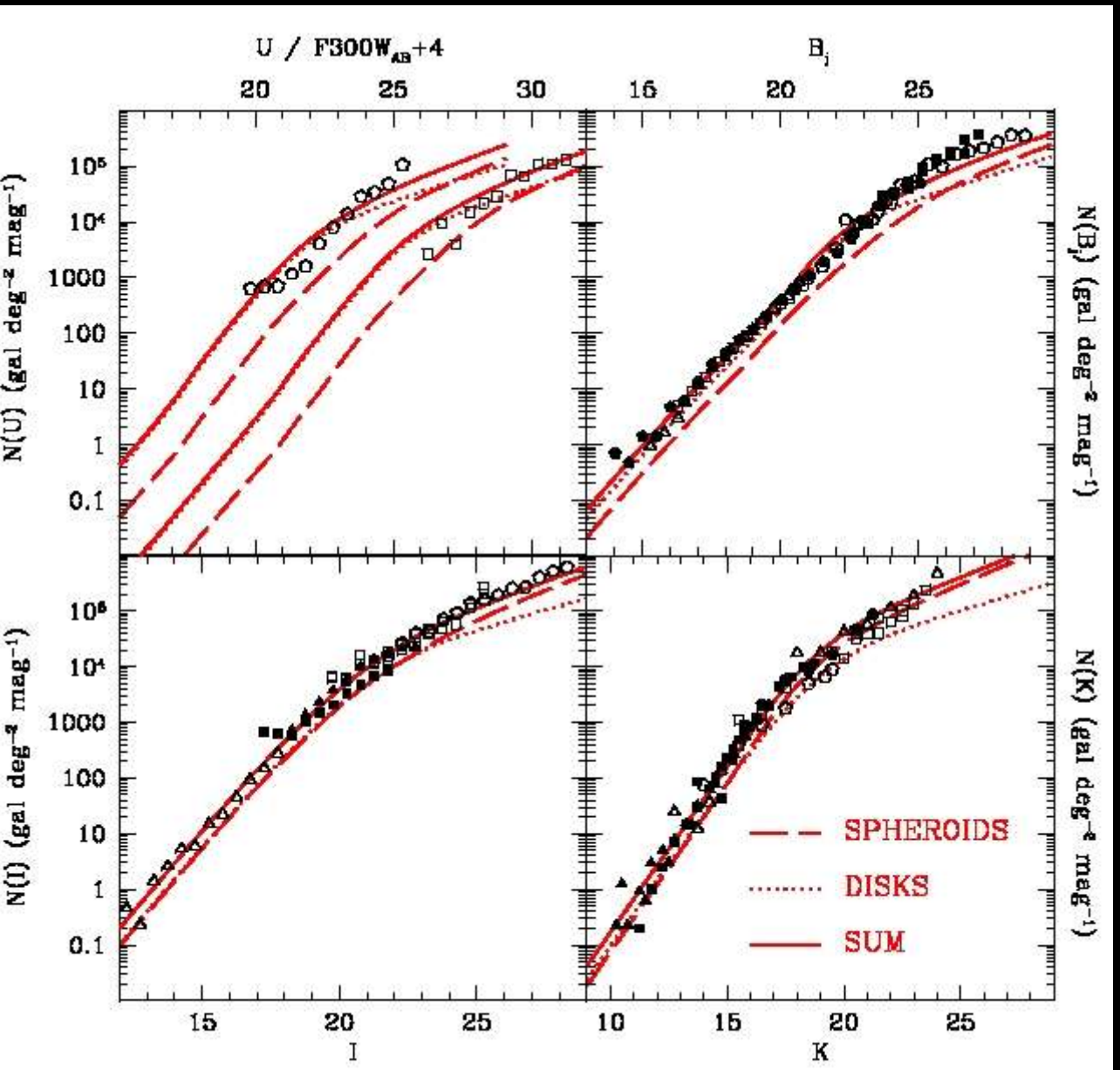
The collision model a.k.a. the morphology driver

Balland et al. (1998) model: calc. Δ = energy exchanged between neighbor gals through grav. inter.



- different Δ thresh- olds give different morphological types
- $\Delta_{ell} \sim 0.01$
  $\Delta_{spi} \sim 0.003$
  calibrated locally to yield correct mor- pholog- ical fraction in spiral S0 transi- tion

Results: Multi-wavelength counts



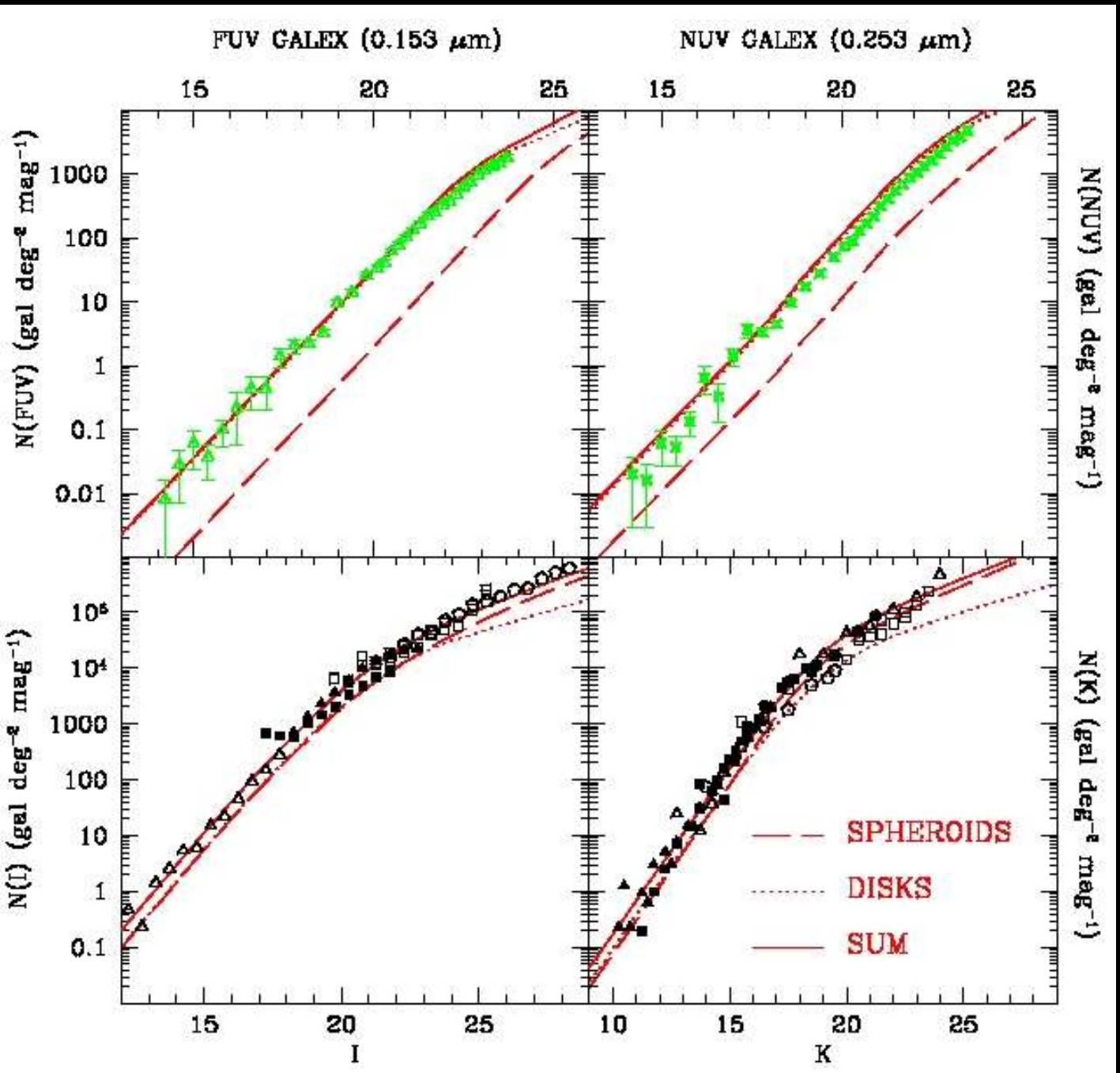
- domination of late type (spiral) galaxies @ the bright end of the counts

for U and B bands and equalish contribution of early type and K(ell) galaxies @ the faint end of the counts

for all bands but more marked in I and K

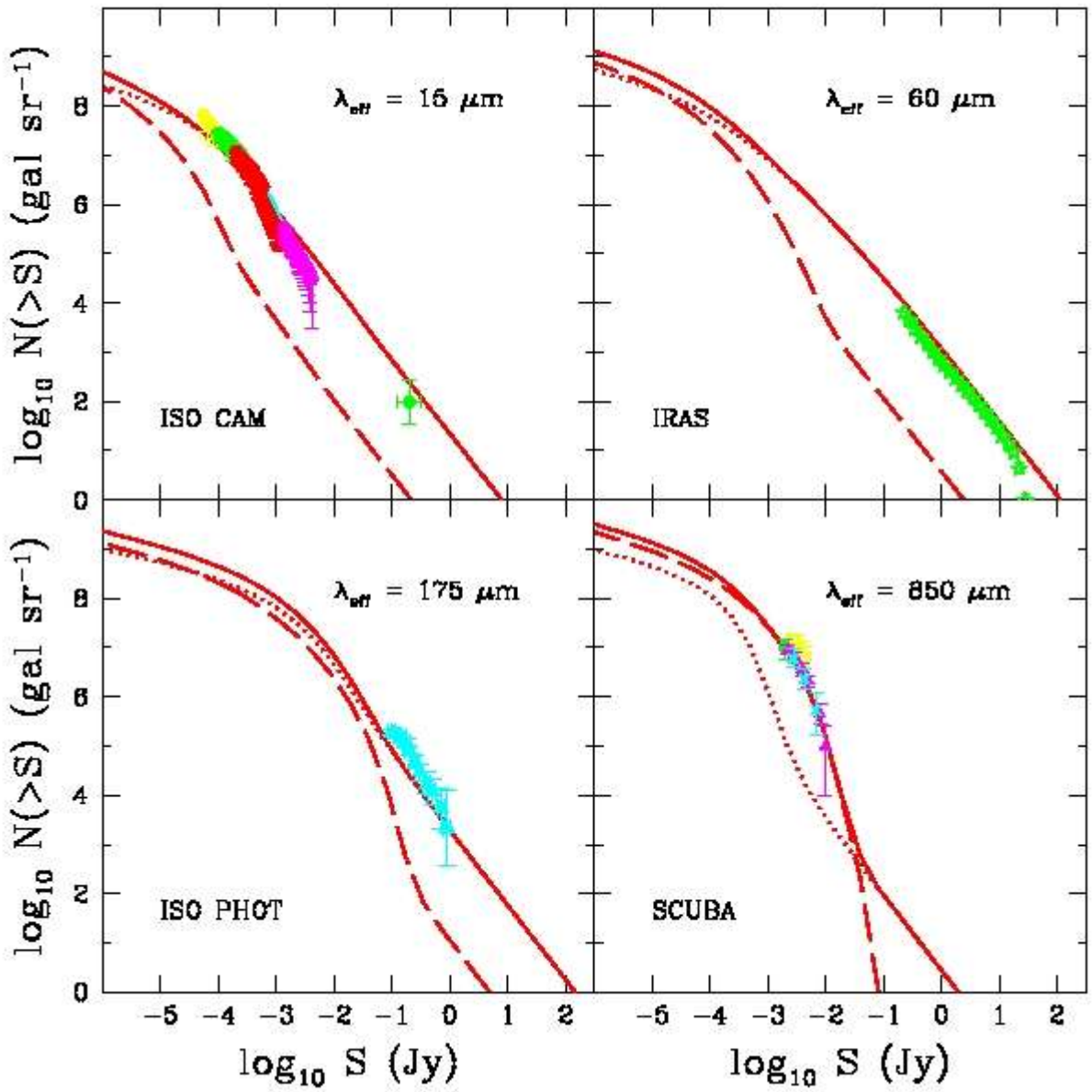
=> natural explanation in terms of stellar popula-

UV Extension: GALEX bands



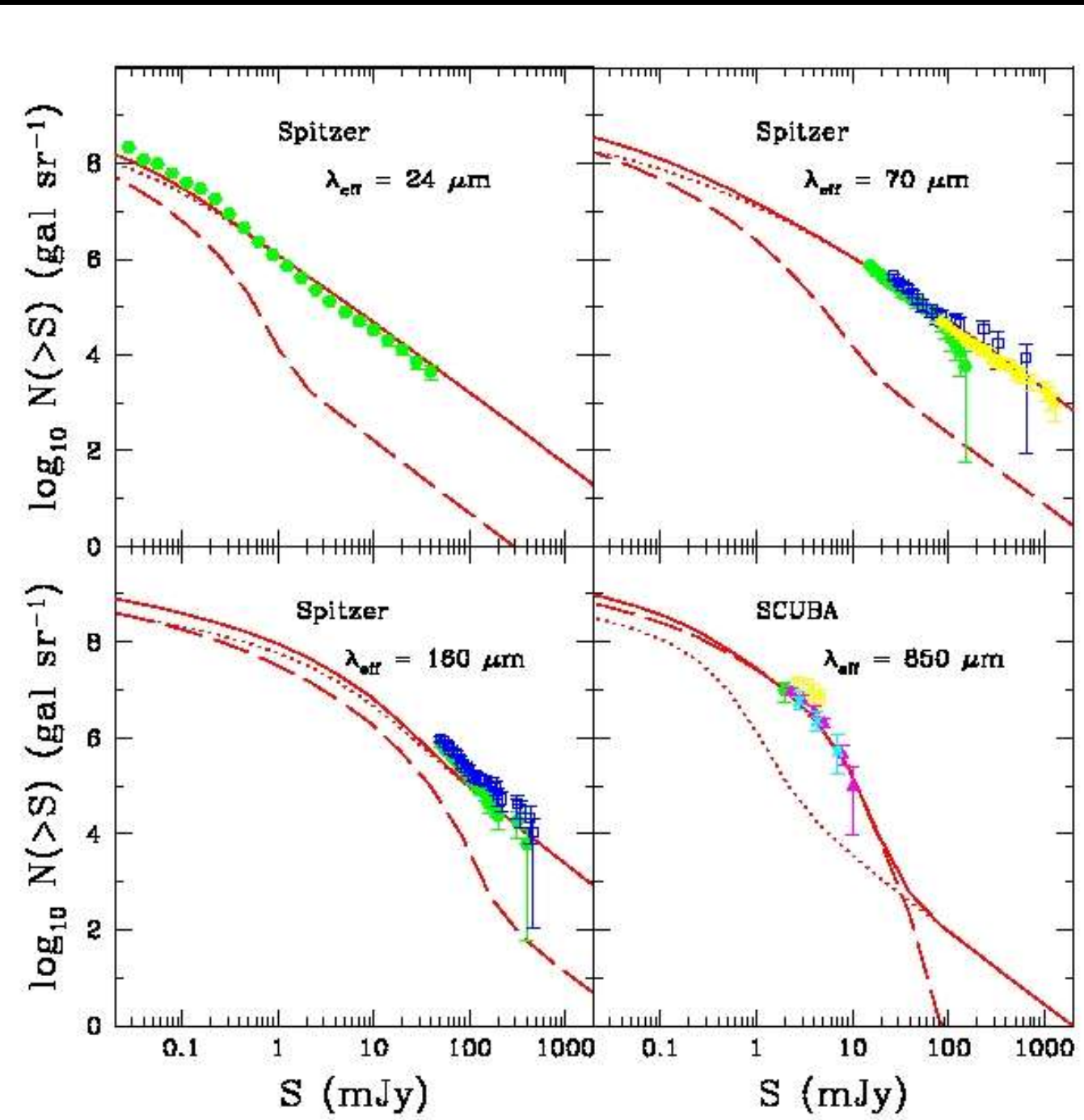
- -> domination of late type (spiral) galaxies @ the bright end of the counts AND @ the faint end as well !

... the 'optically-dark' counts



- similar trend as in the optical bands with late type (spiral) galaxies dominating @ the bright end of the counts for all bands *except* the sub-mm
- explanation in terms of dust emission peak between 60 and 150 microns *and* negative k-correction making distant galaxies as bright as local

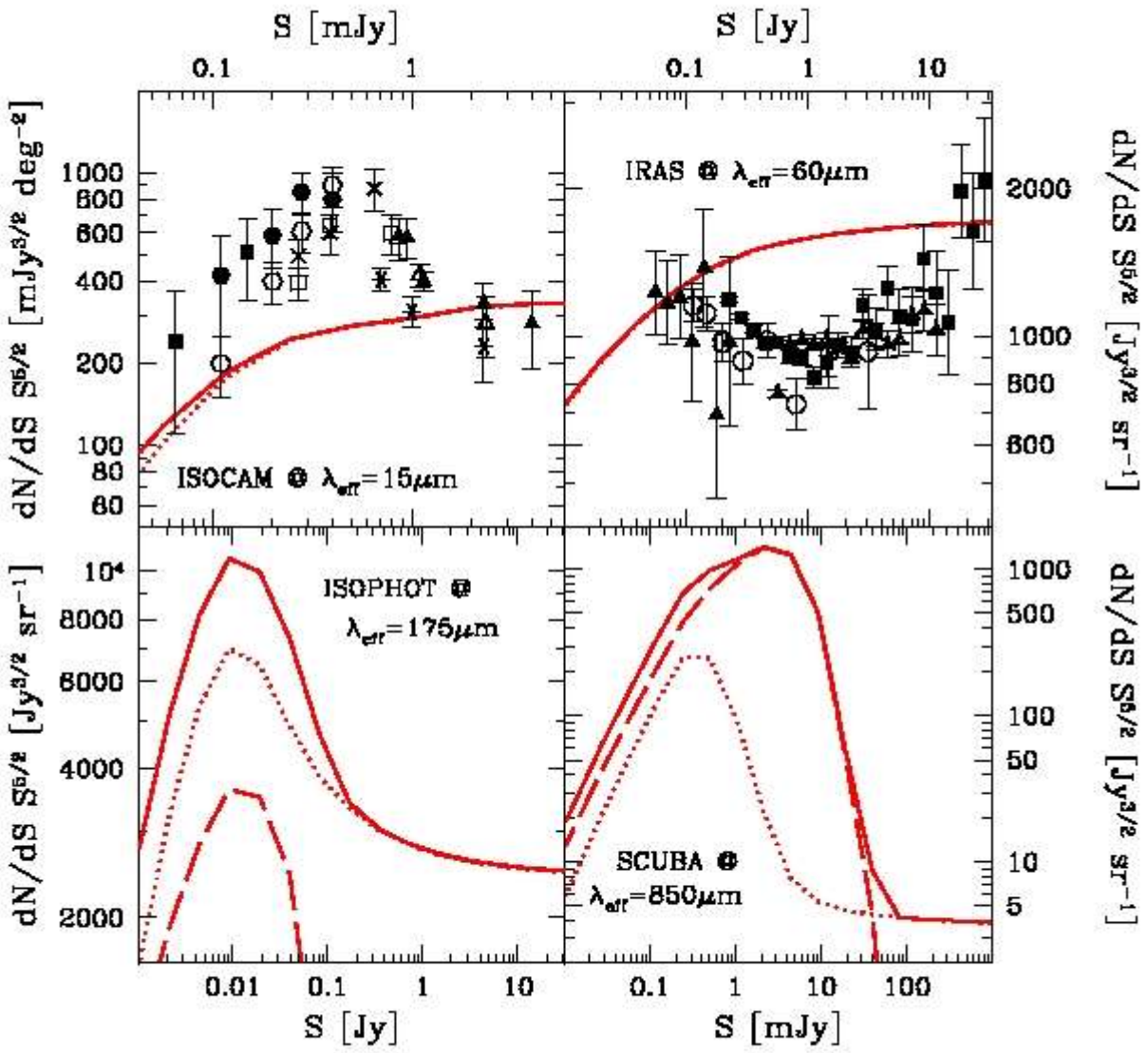
... in Spitzer's bands



previous conclusions remain unchanged

however one can begin to spot trouble with the faint end Spitzer faint counts at 24 microns ...

Differential counts

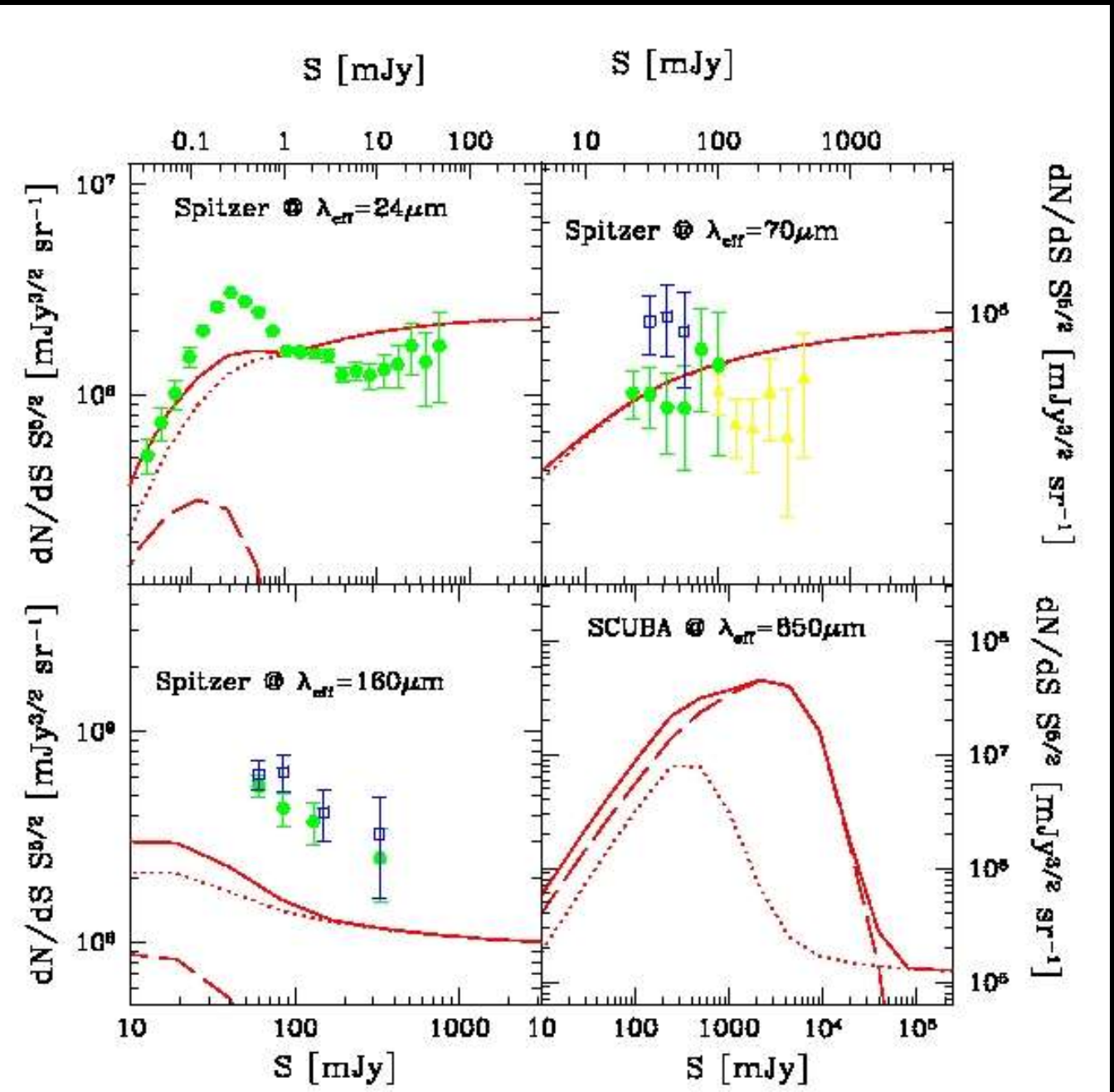


- a zoom on the details shows that the agreement between model and data in the IR is far from perfect ...

in particular models cannot reproduce change of slope observed in the data

+ most likely culprits:
+ detailed shape of the SEDs
+ modelling of interactions

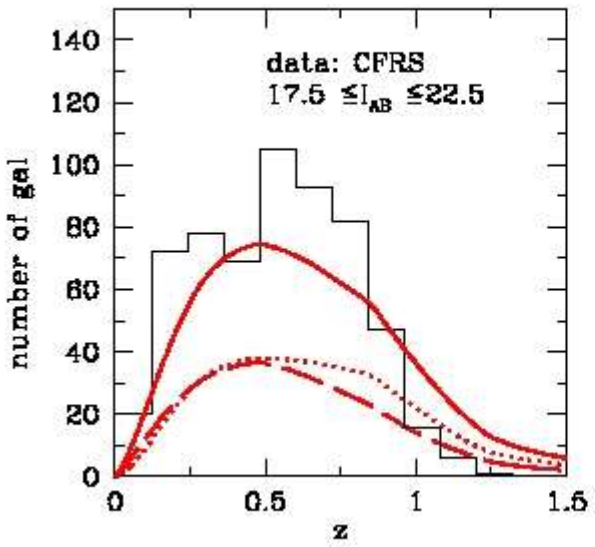
... in Spitzer's bands

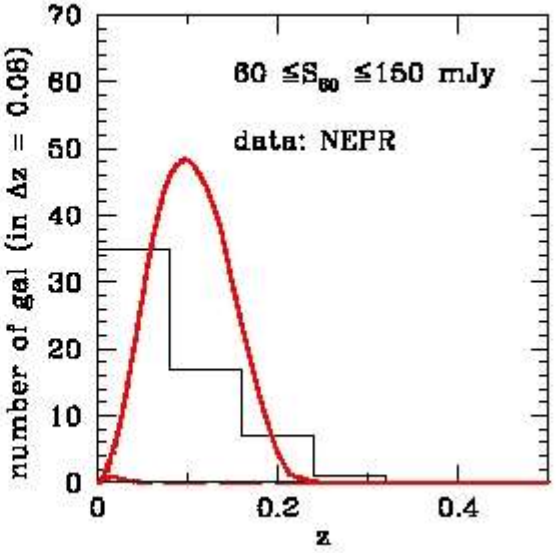


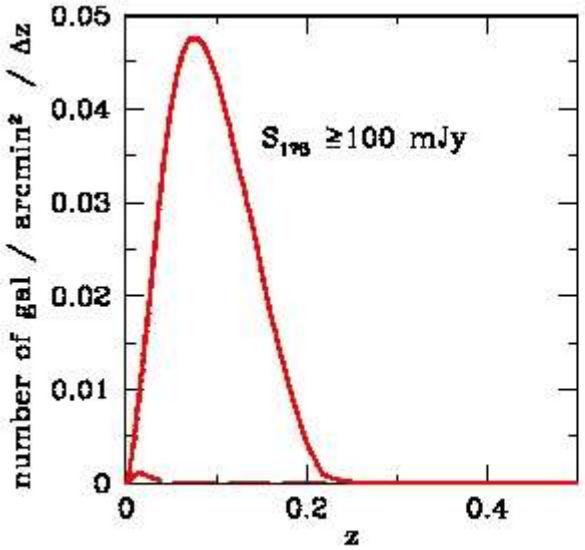
a note that the position of the peak of model ellipticals is at the right place ... suggestive of an underestimate of the starburst phase contribution

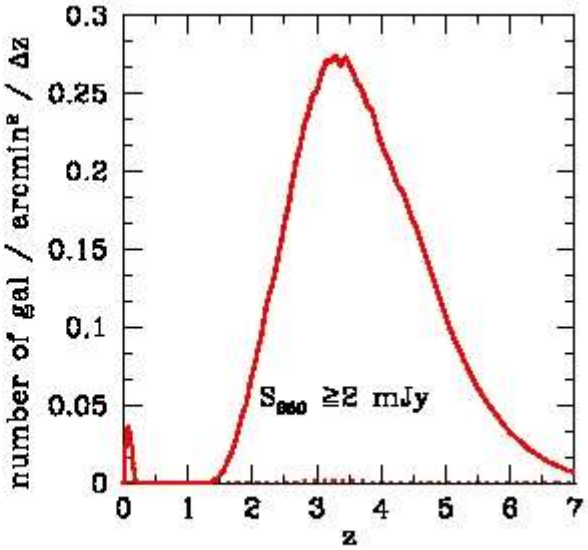
also strong dependence of the mid-IR flux and so counts on the contribution of PAHs

Redshift distributions



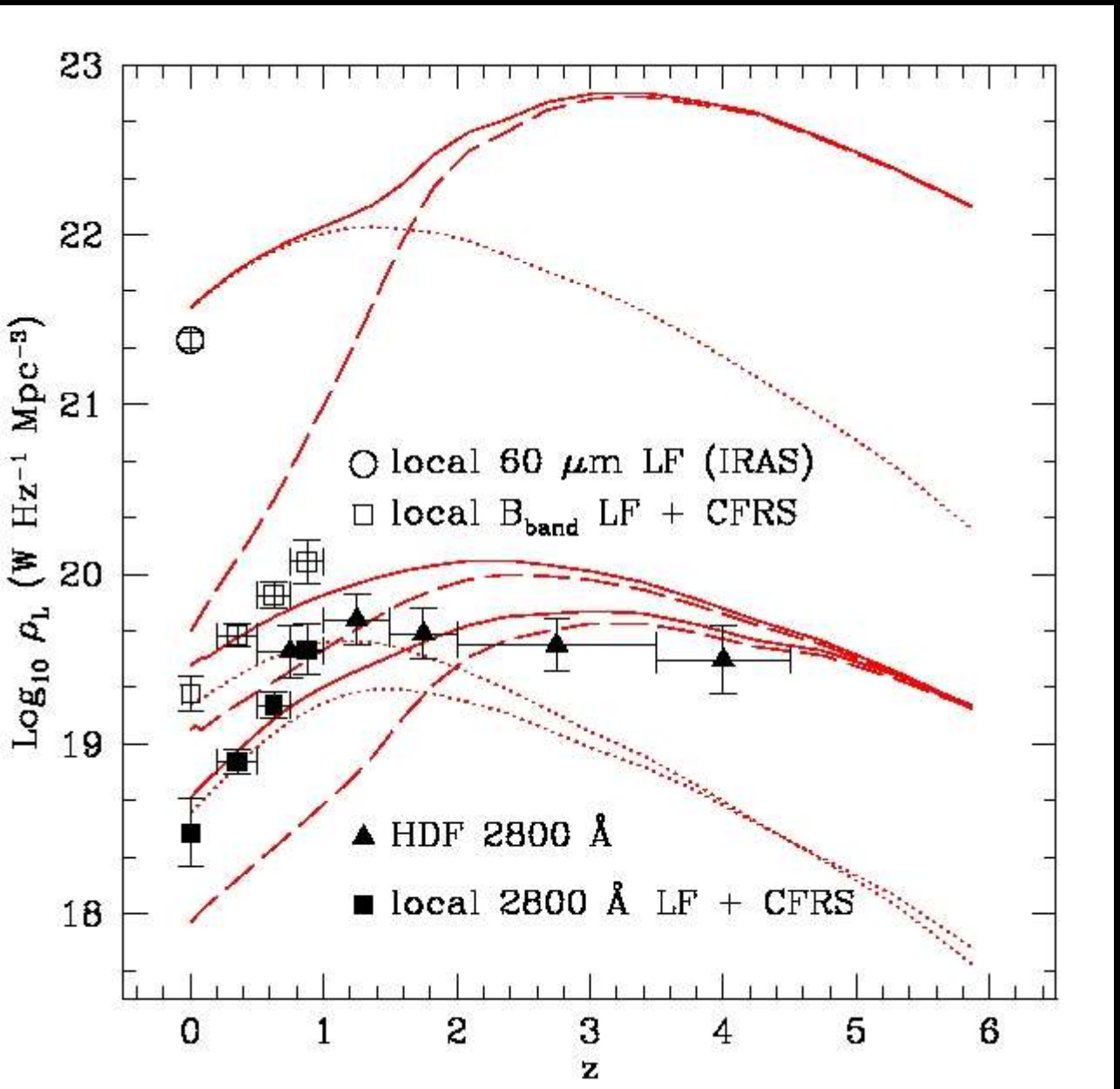






- domination of late type (spirals) galaxies is marginal in the I band @ all redshifts but complete @ low redshifts in all other bands even in the sub-mm
- characteristic double peak distribution in the submm --> negative k-correction missing in the far-IR too warm SEDs ?

Comoving luminosity densities

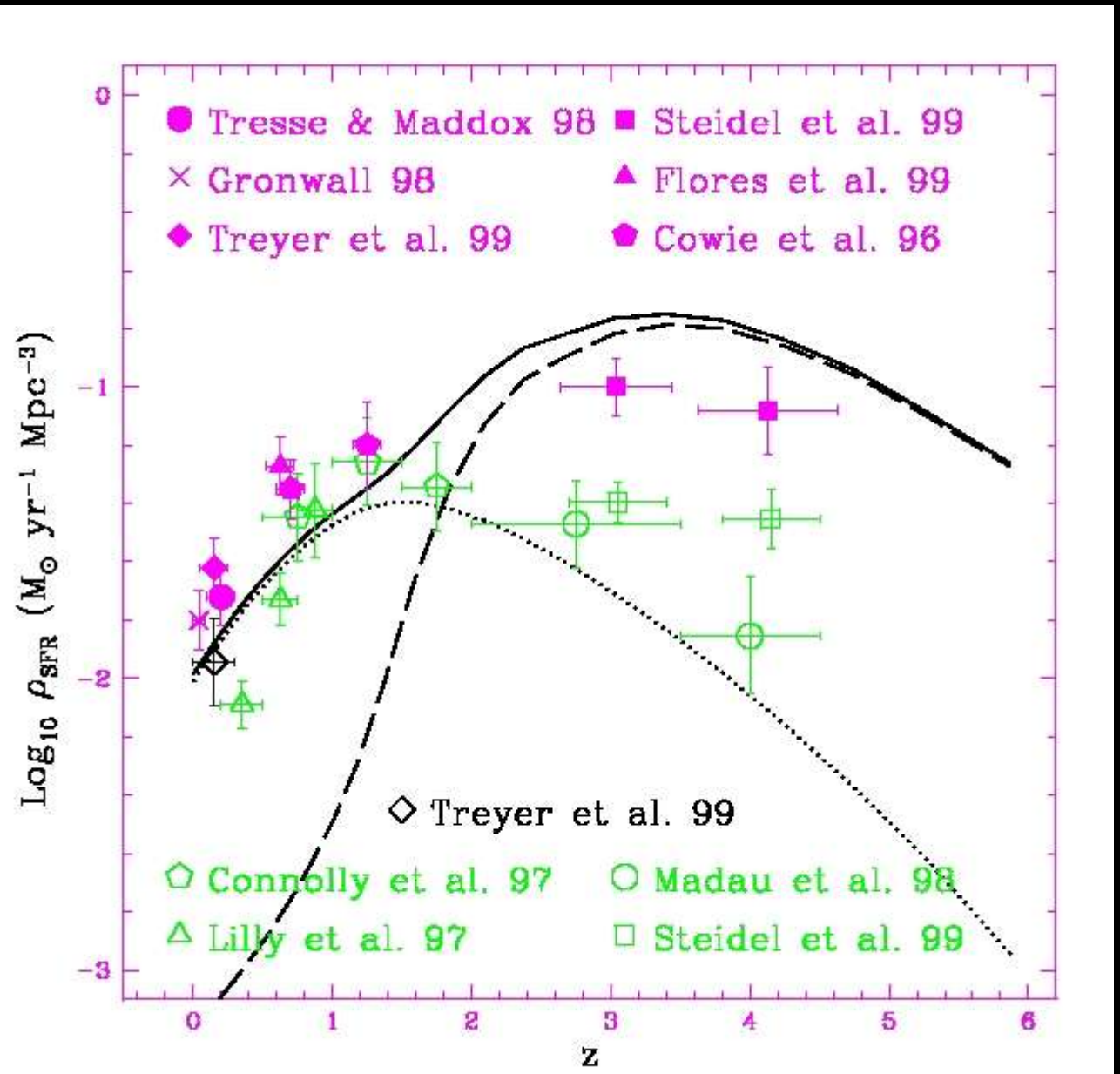


- domination of late type (spirals) galaxies @ all wavelengths @ lowish redshifts ($z < 1$) but still a significant contribution of spheroids (except in the UV and far-IR with peak at $z \sim 3$)

- synchronization of far-IR due to a more pronounced sensitivity to the instantaneous SFR

- rapid evolution takes place in the far-IR

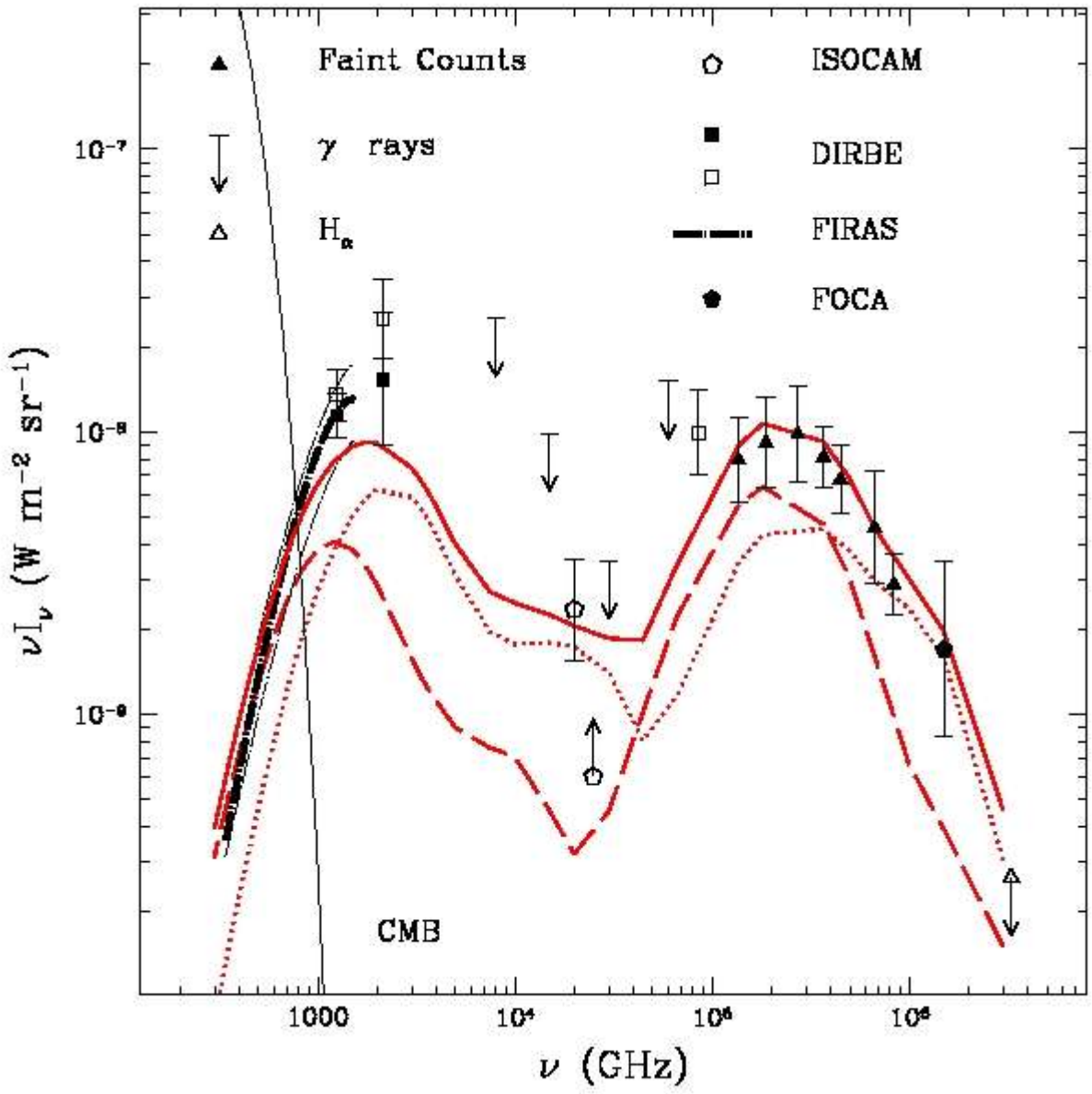
Cosmic star formation



- prediction of a broad peak around $z \sim 3.5$ which is sensibly higher than the assumed value ($z \sim 1$)

- possible slight underestimate of late/early type galaxy contribution @ moderate ($0.5 < z < 1$) red shifts

Diffuse background light



- global galaxy luminosity budget seems quite satisfactory
- domination of early type (ells) galaxies @ wavelengths greater than 200 microns and between 2 and 5 microns
- likely slight underestimate in the far and mid-IR again probably due to SED shapes and/or crude interaction modelling

Conclusions

- Presented a simple but physically motivated SAM which globally reproduces the observed evolution of galaxies @ intermediate and low z
- Main strength of the approach is its simplicity (almost analytic) and the detailed (morphology) panchromatic predictions it can make (solves IR pb)
- More to come: re-ionization and panchromatic predictions for galaxy