Populations of ULIRG/AGNs from the Mid-IR Deep surveys at 12um, 24um

Discovery of ULIRGS as massive dusty ellipticals

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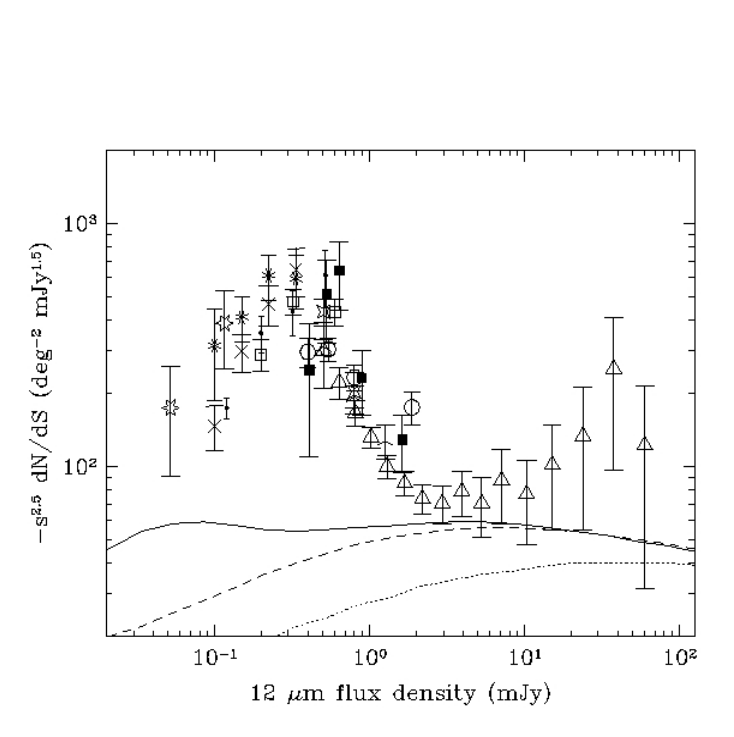
astroph-0705.2031, 2007 & in press AA

- **Galaxy Number Density Excess observed at 24um/MIPS and at 15um**
- **A new deep galaxy survey at 12um on the ESO-Sculptor area (Seymour et al,submitted) confirms the excess.**
- **Our new code PEGASE.3 predicts continuous SEDs from far-UV to far-IR with coherent dust emission/extinction by galaxy types**
- **Modeling faint galaxy counts in the MIR requires a new population**
- **This population shows similarities with distant radio galaxies**

The new ISOCAM deep survey at 12um

Seymour, Rocca-Volmerange, de Lapparent, submitted to AA

~800 arcmin2, complete down to 0.1mJy (with corrections), solid flux calibration, covering 80% of the ESO SCULPTOR Field (z-survey and deep optical photometry; de Lapparent et al, 2003)=> catalogue of 142 galaxies.



THE DIFFERENTIAL EXCESS OF GALAXY COUNTS, COMPARED TO EUCLID

One unique model PEGASE (7 types) FITS DEEP UV/OPTICAL/NIR COUNTS (Fioc et al. 1999, AA, 344, 393 and http://www2.iap.fr/pegase)

ELLIPTICAL(26%), Sa+Sb+Sbc(24%), Sc+Sd+Im (50%) with EVOLUTION

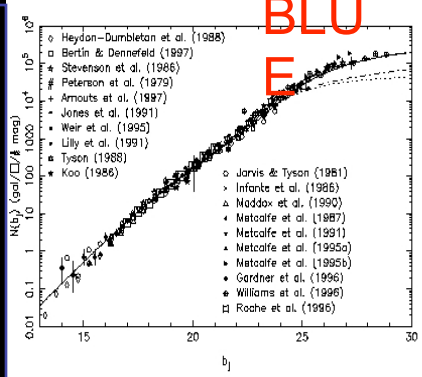
PEGASE SCENARIOS ARE ROBUST

STAR FORMATION BY TYPES

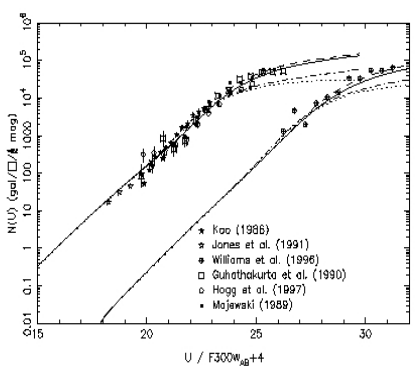
SFR(t) = τ* $M_{gas}(t)$ (τ*= 10/0.06 Gyr^{-1}/Mo)

- **INFALL TIME SCALE :0.3/8Gyr**
- **GALACTIC WINDS: Ell @ t<3 Gyr**
- **IMF :** Standard
- TRANSFER model for disk/ spheroid
- METALS, DUST, GAS = F(time)

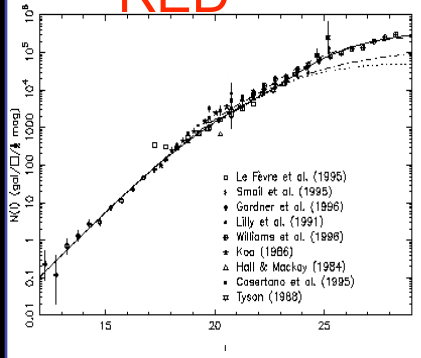
BLU E



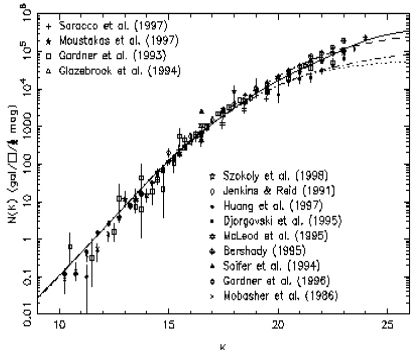
UV



RED



NIR



Multi spectral faint galaxy counts Fioc & Rocca-Volmerange, 1999, AA,344, 393

IS THIS MODEL VALID TO INTERPRET THE MID-INFRARED COUNTS ???

PEGASE.3 IS EXTENDED TO DUST EMISSION IN THE MID- and FAR- IR (Fioc, Dwek, Rocca-Volmerange et al, 2007, in preparation)

Main Characteristics:

•METALS=>DUST

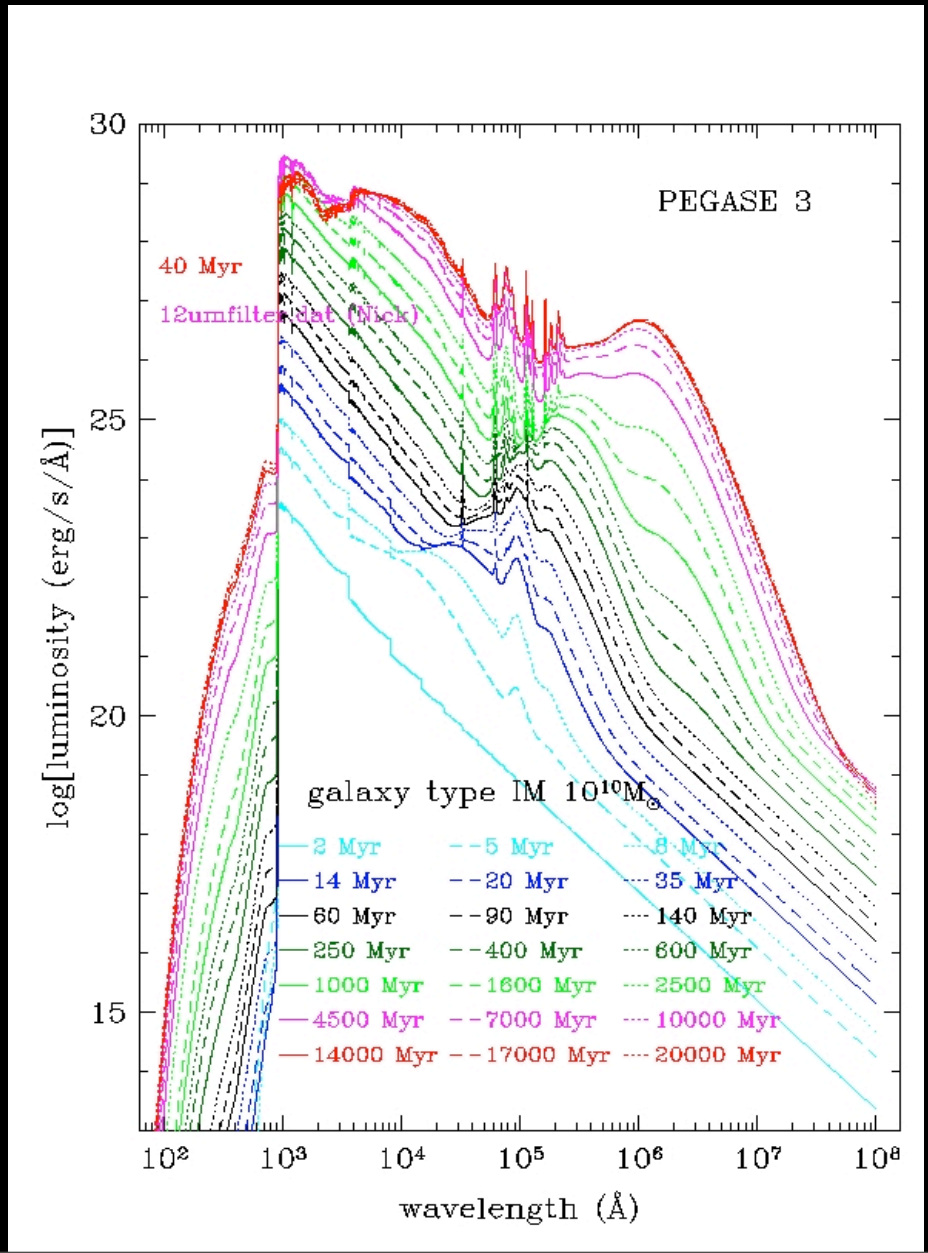
•ISM + HII regions

•Standard grain models

•Extinction, coherent with IR Emission and ionized gas

8 galaxy types: ELL-SPIRALS-IM

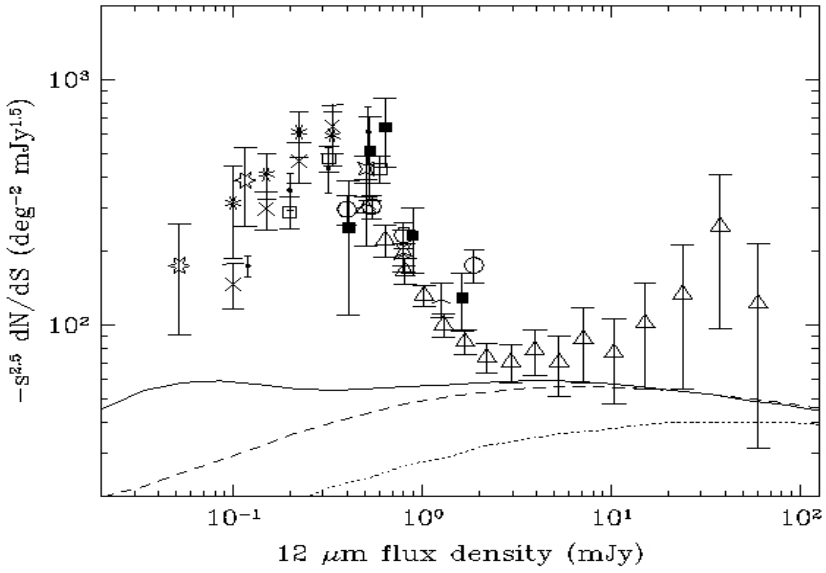
•FITS SED of standard Galaxies from 90/10^8A



PEGASE.3 used to interpret the galaxy excess @ 12um/ISOCAM survey

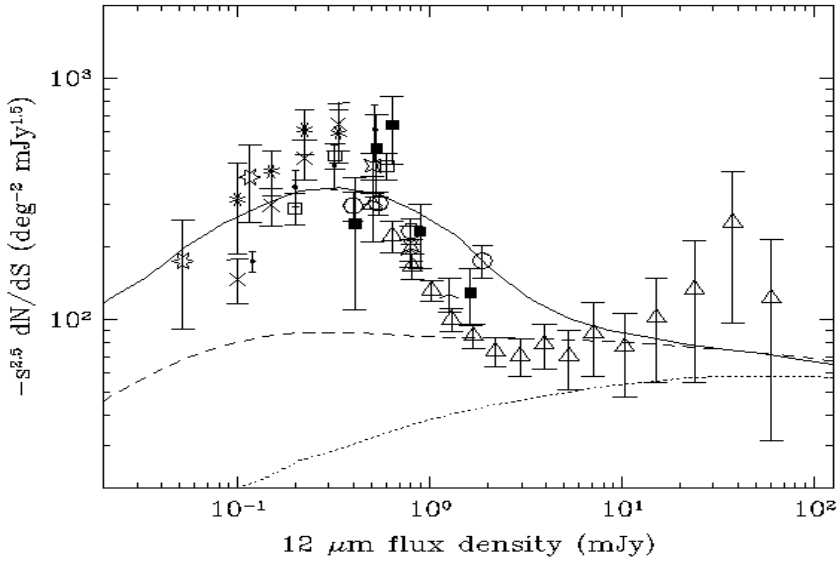
NO FIT

NORMAL GALAXY POPULATION
From the UV/optical/NIR
26%Normal Ellipticals
24% Early Spirals
50% Late spirals



FIT WITH ULIRG POPULATION

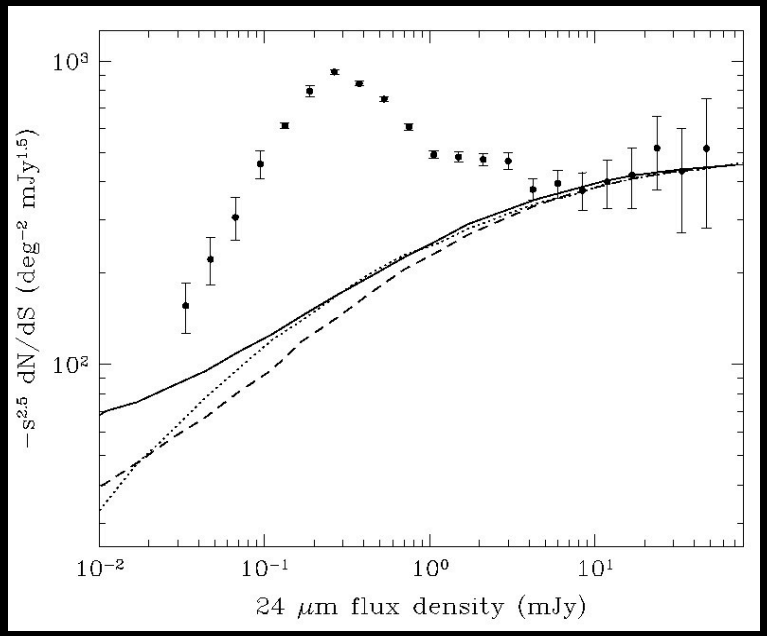
NORMAL+« ULIRG »POPULATIONS
9%dusty ultra-bright ellipticals: ULIRG
15% normal ellipticals
24% Early Spirals
50% Late Spirals

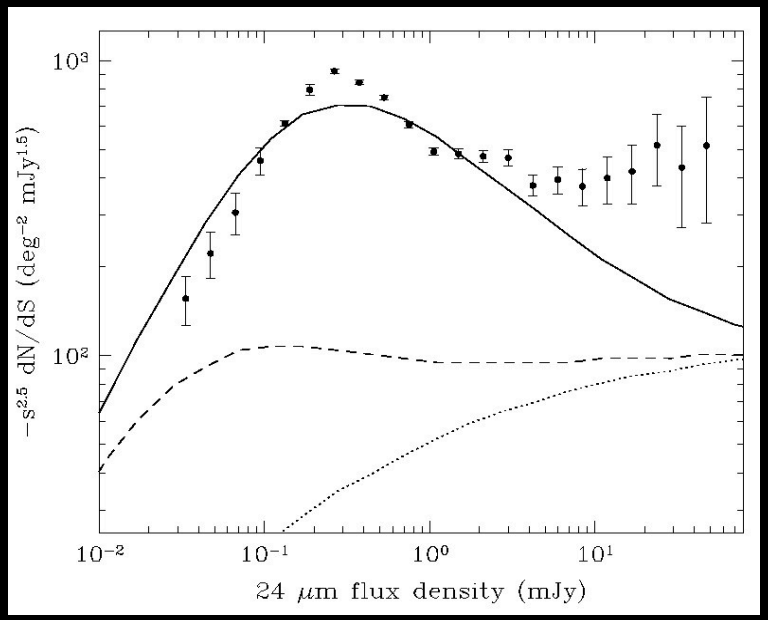


Full line: k+e corrections, dashed line: k- corrections, dot line: comoving volume

The same Model FITS also

With ULIRGs





THESE COUNT RESULTS ARE BASED ON OBSERVED LUMINOSITY FUNCTIONS at 12 and 25 um from IRAS and B-Mid-IR colors by types in standard cosmology
THEY REMAIN COMPATIBLE WITH THE UV/optical/NIR INTERPRETATIONS

The evolving ULIRG population

- ULTRA-BRIGHT (2 mag > normal)
- ELLIPTICAL SCENARIO (same SFR)
- LARGE MASS OF DUST (normal ellipticals are gas-poor because winds)
- ONLY 10% of ALL GALAXIES (1/3 of ellipticals)

➔ MIR EXCESS traces a population of ULIRGs as

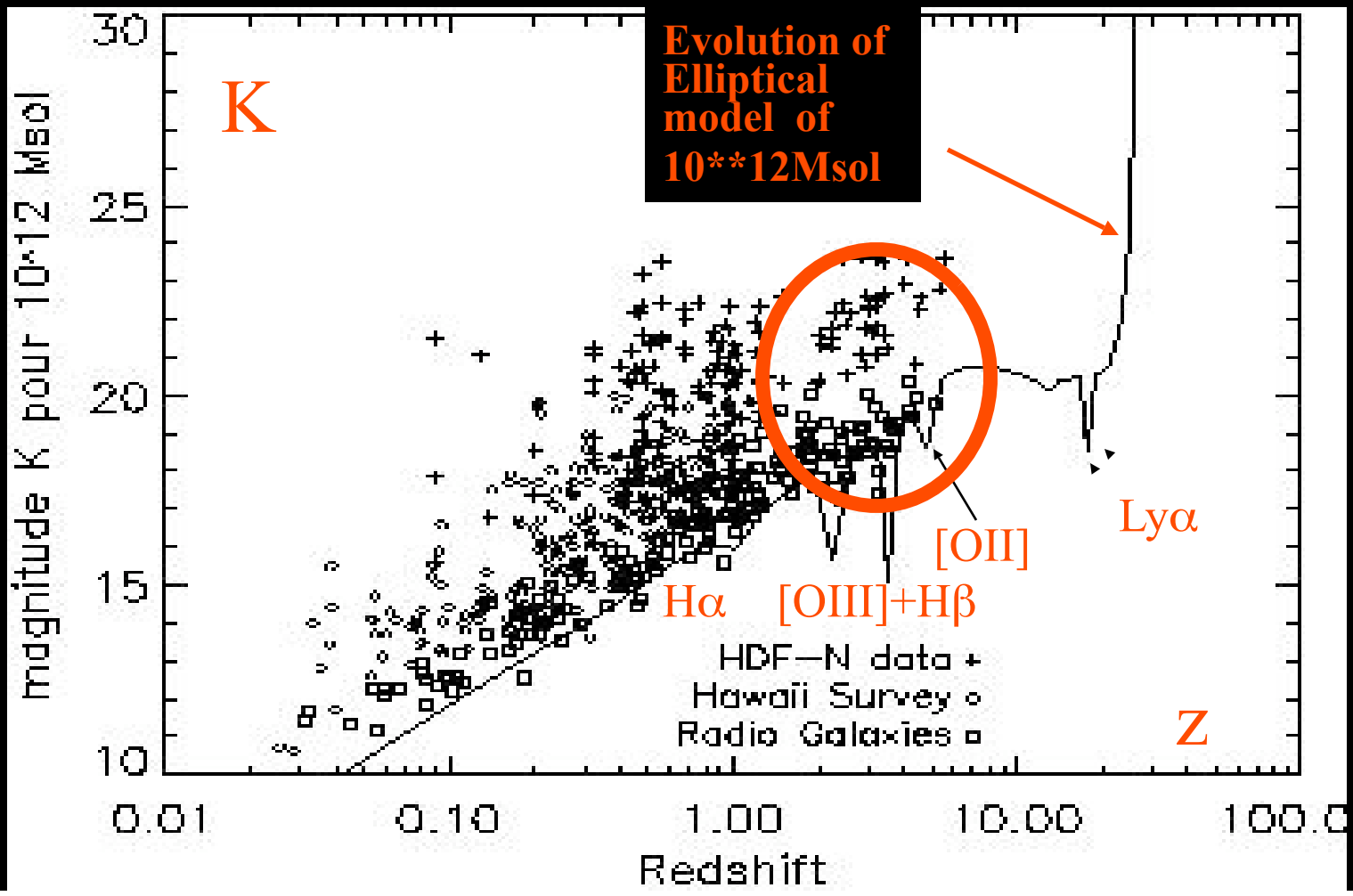
Evolved Galaxy including large mass of dust

and an extincted embedded AGN/starburst

Note: nearby ULIRG from interacting galaxies are rare

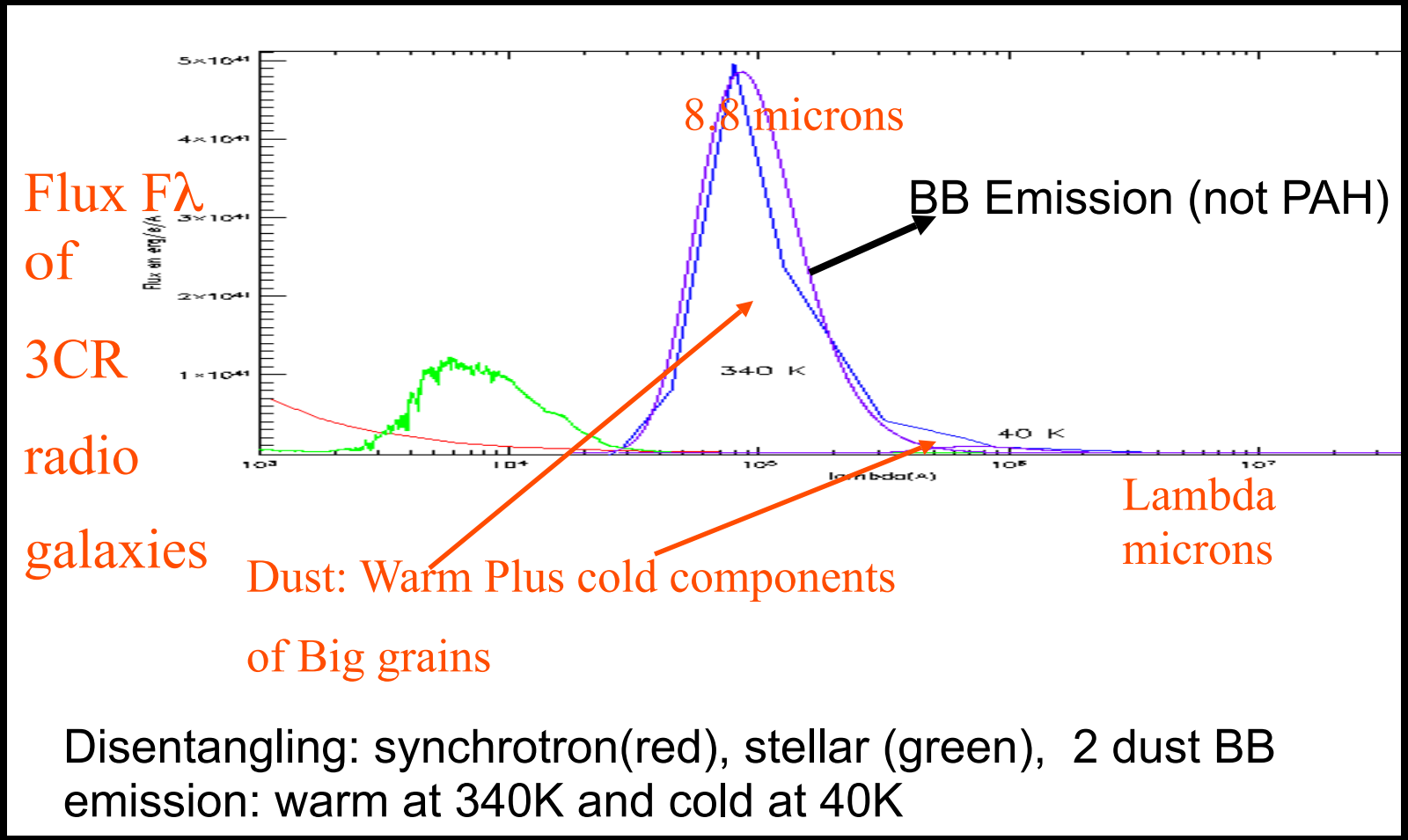
ULIRGs belong to the same family of distant ellipticals than radio galaxy hosts

Powerful Radio Galaxies are embedded in massive ellipticals of mass limit 10^{12}Msol

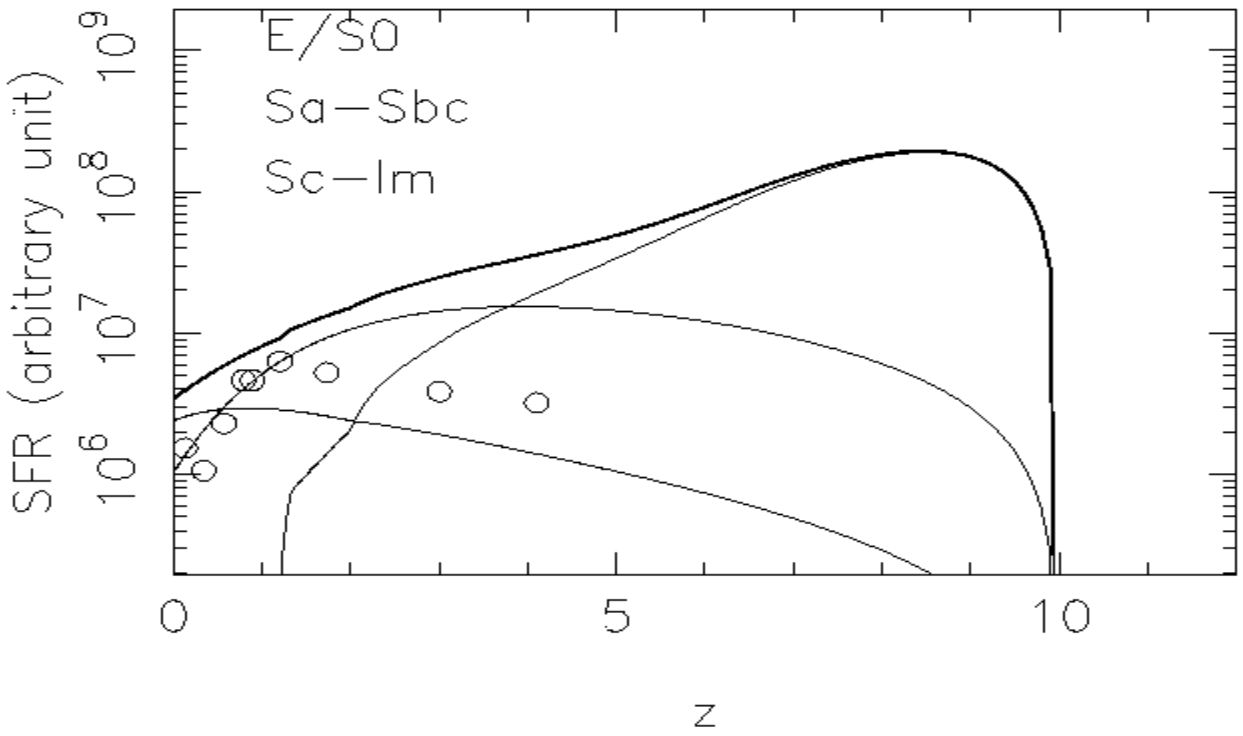


(Rocca-Volmerange et al, 2004, AA, 415, 931)

3CR Radio Galaxy contains hot dust (340K) and cold dust (40K), Rocca-Volmerange and Remazeilles, 2005



Populations of high-z ellipticals implies the STAR FORMATION



Rocca-Volmerange et al. 2007, astroph 0705.2031 , in press AA

Conclusion

- The excess/euclidian in MID-IR surveys is interpreted by 10% of dusty ultra_bright ellipticals
- The ultra-brigthness (2mag) is possibly due to mass, embedded AGN or minor starburst heating dust
- All these results remain compatible with the populations from UV/optical/NIR counts
- ULIRGs and Radiogalaxies have similar properties at high redshifts : mass of stars, dust, possible AGN
- For these galaxies as for elliptical galaxies formed at high z,

EVOLUTION SCENARIOS BY TYPE (SFR, winds, accretion)

- Fioc & Rocca-Volmerange, 1997, 1999 (PEGASE code)
- Le Borgne, Rocca-Volmerange, Fioc, 2002 (phot z code Z-PEG)

Elliptical galaxy

Spiral Galaxy

SFR