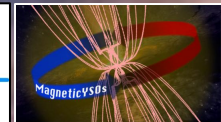


IAU 2018 - Vienna

The properties of interstellar dust in the local Universe

Maud Galametz, CEA Saclay

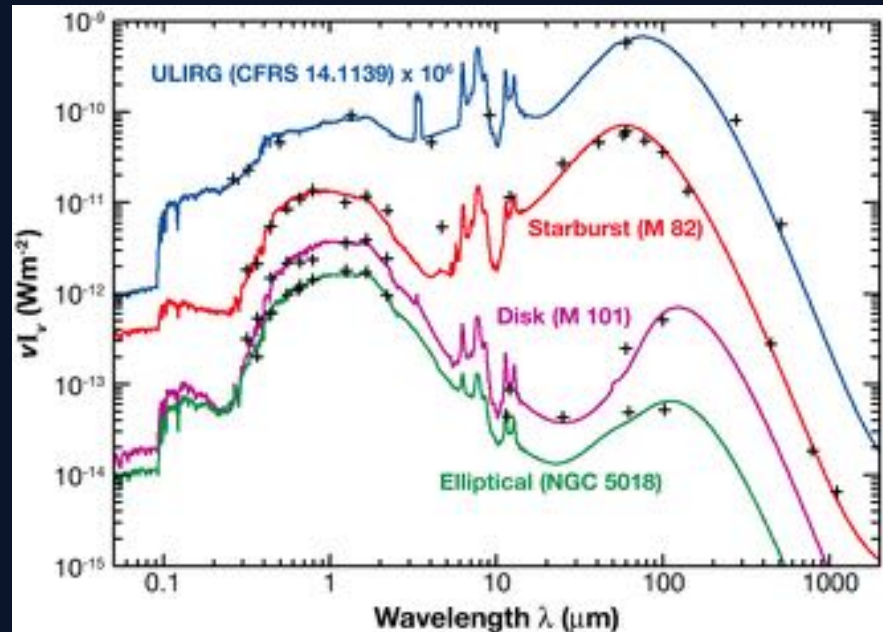


DUST : A TRACER OF GALAXY EVOLUTION

Local Universe: different laboratories to understand dust properties

Dust reemits from 30% to 90% of the stellar power

**Effects of dust evolution on the
SED itself**



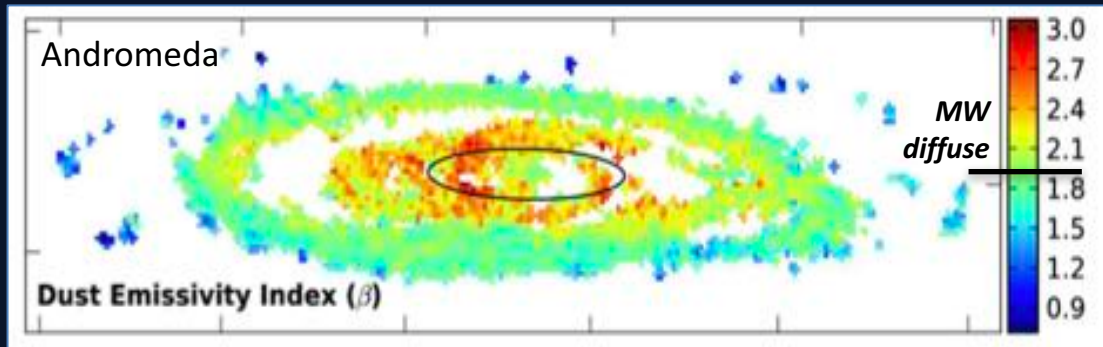
Dust modelling and current revisions

VARIATION OF BETA IN NEARBY GALAXIES

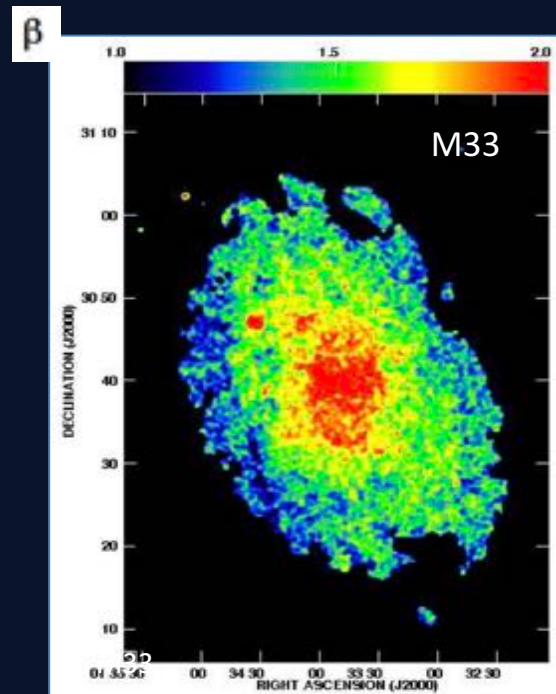
The Modified blackbody model, a classical prescription

$$L_{\nu}(\lambda) = M_{\text{dust}} \cdot \kappa(\lambda_0) (\lambda_0/\lambda)^{\beta} \cdot 4\pi B_{\nu}(\lambda, T_{\text{dust}})$$

Emissivity index



Smith et al, 2012



Tabatabaei et al, 2013

BETA-T ANTI-CORRELATION

Explanations?

- Laboratory experiments on dust analogues

Coupeaud et al. 2011; Demyk et al. 2017

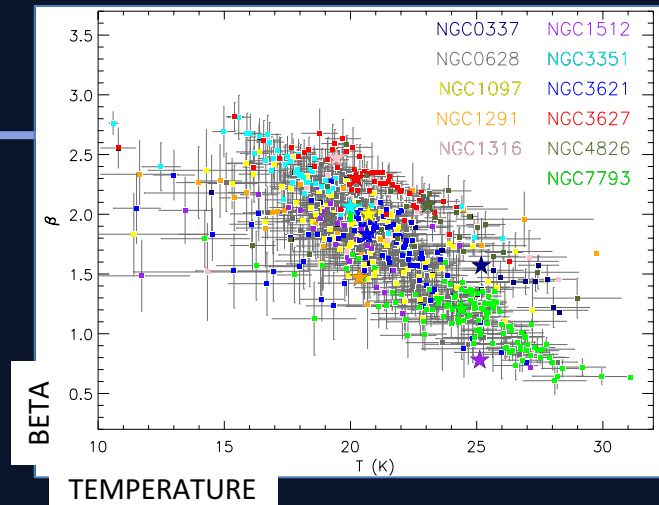
- changes in the composition and structure of silicate or carbon dust

Meny et al. 2007; Jones et al 2013

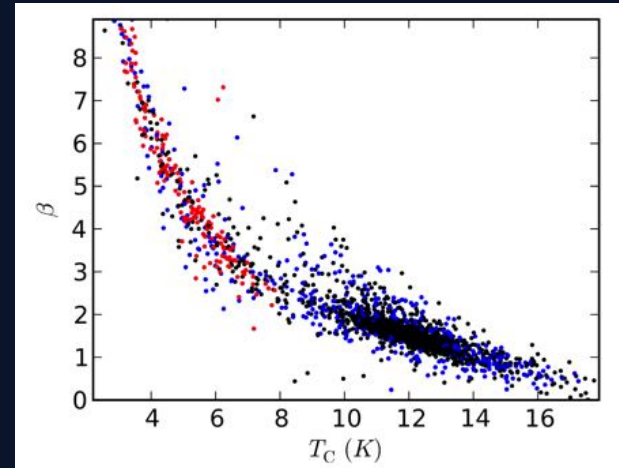
BUT

Degeneracies between the dust color temperature and the observed spectral index

Juvela & Ysard 2012



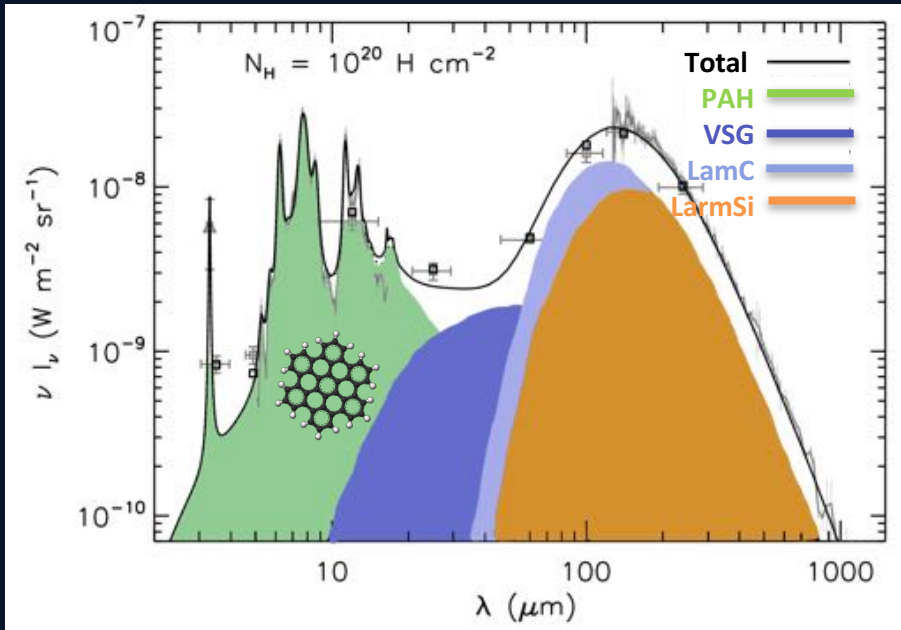
Galametz et al 2012



DUST, A COMPLEX MIXTURE

PAHs

Their emission varies with their ionization, size ...



Very small grains

Small grains

Sizes < 20nm

Can vary significantly

Large grains

Carbonaceous grains

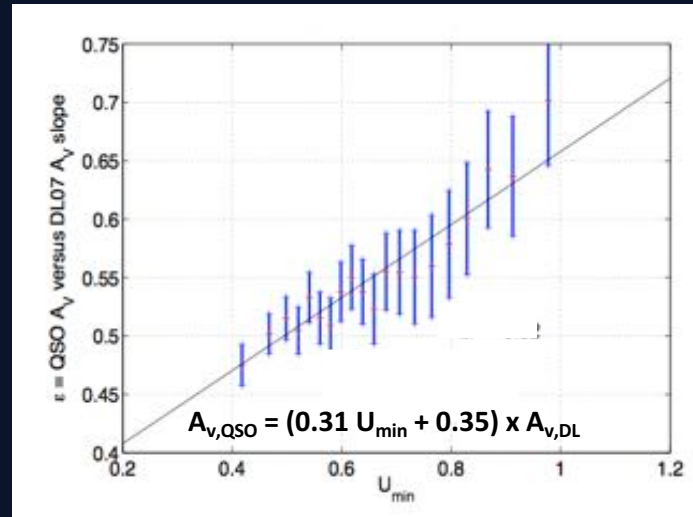
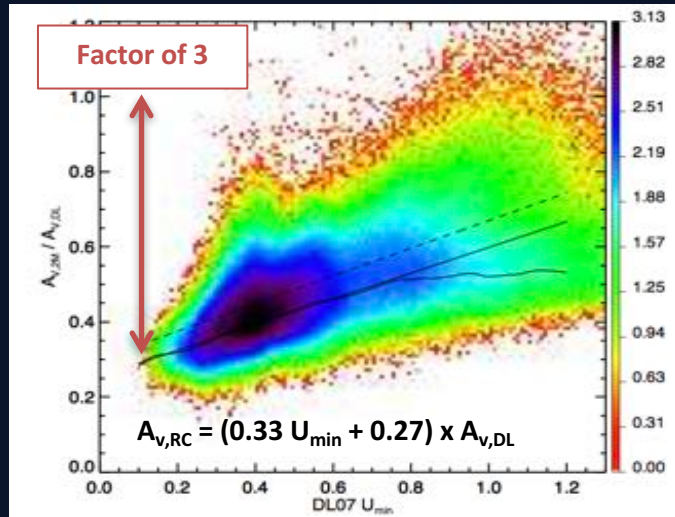
and

Amorphous silicates

Grains at thermal equilibrium

CONSTRAINTS ON THE DUST OPACITY FROM PLANCK

- Model the Galactic IR/submm emission (Planck, IRAS, WISE)
- Compare $A_{v,DL}$ with stellar observations in molecular clouds
optical estimates from QSOs in the diffuse ISM

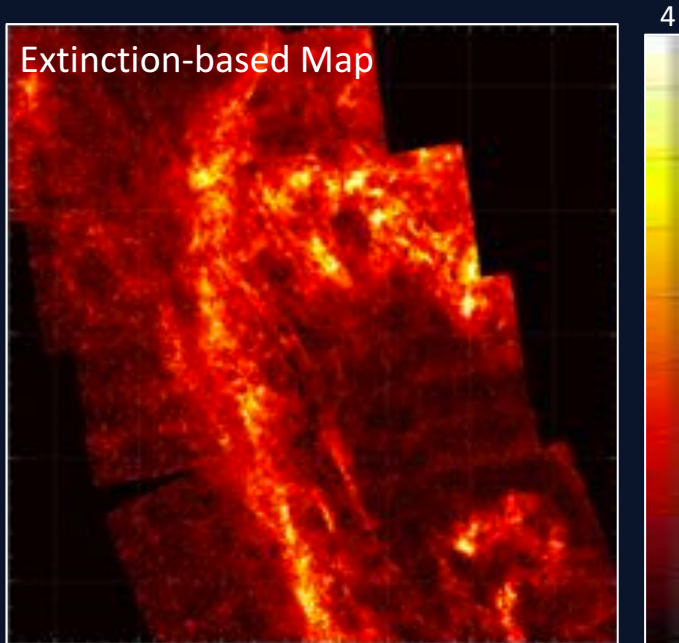


Planck
Collaboration 2014
(Paper XXIX)

→ Not the right far-IR opacity of dust grains, even in the diffuse ISM

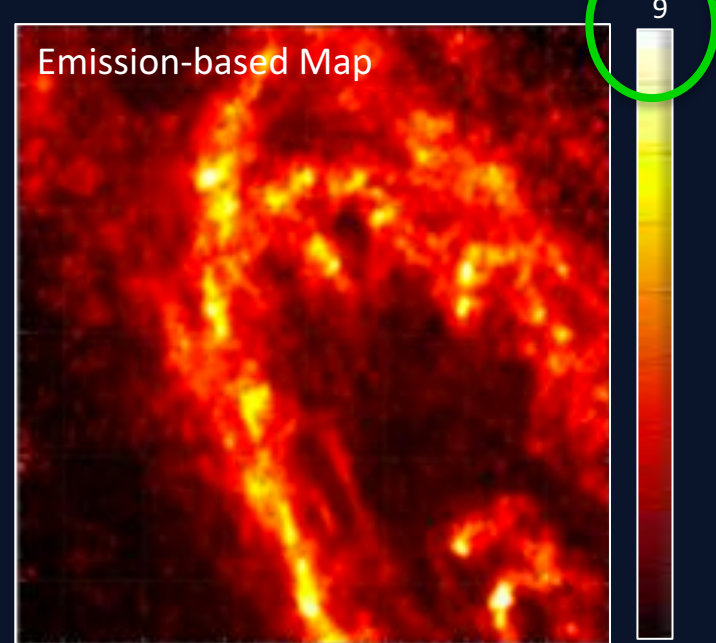
CONSTRAINTS ON THE DUST OPACITY FROM PHAT

The same discrepancy is observed in Andromeda



Dalcanton et al 2015

0



From Draine et al 2014

0

→ Revision of the physical properties of current models

Evolution of dust grains in the ISM

DUST EVOLUTION PROCESSES

Grain Formation

- Grain condensation (Sne ejecta, AGB stars)
- Accretion of atoms and molecules (growth, mantle, ice) in the ISM

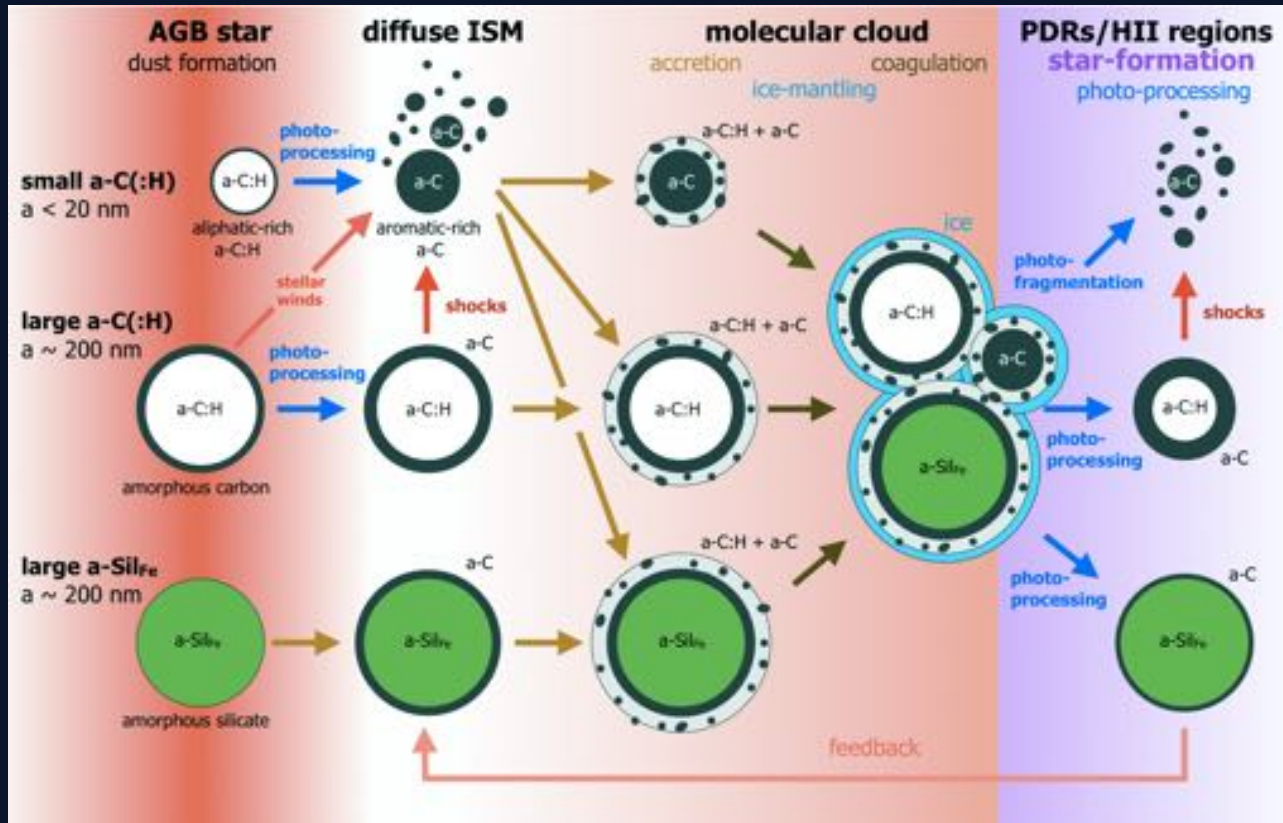
Grain Processing

- Shattering, fragmentation by grain-grain collisions
- Structural modifications (high energy photons, cosmic rays)
- Coagulation

Grain Destruction

- Erosion (thermal or kinetic sputtering)
- Photo-desorption of atoms and molecules
- Thermal evaporation
- Astration (incorporation into stars)

DUST EVOLUTION PROCESSES

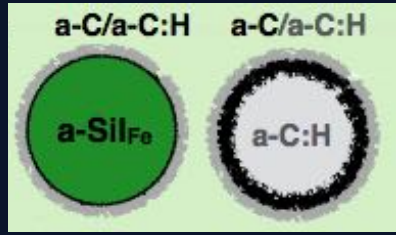


From Jones et al 2013; schematic diagram of the THEMIS model

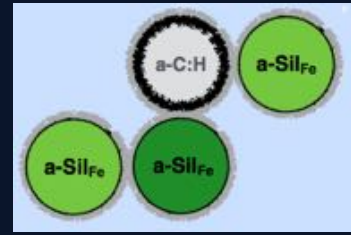
EMISSIVITY VARIATIONS



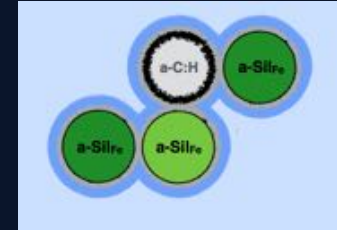
Core-mantle



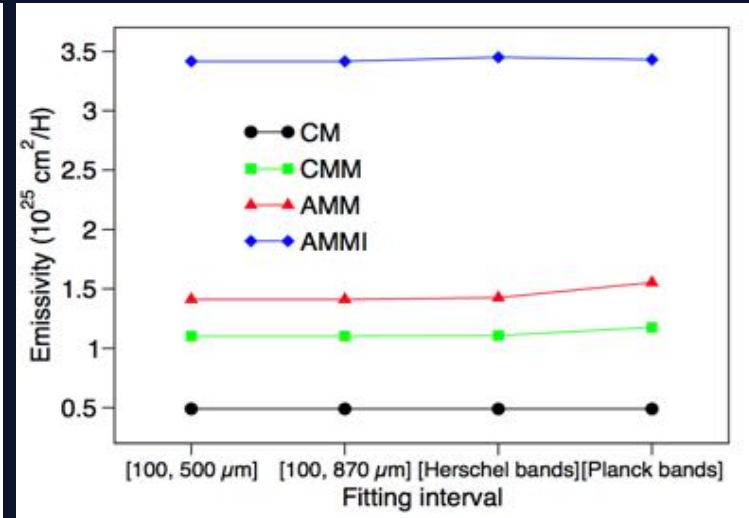
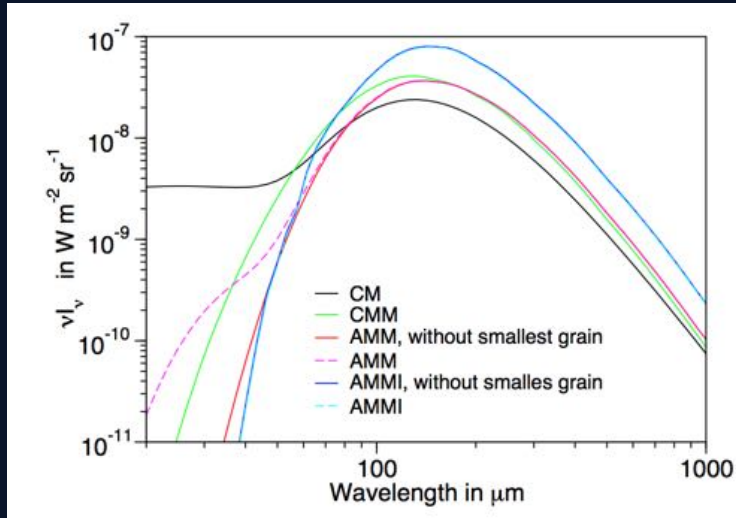
Core-mantle-mantle



Aggregates

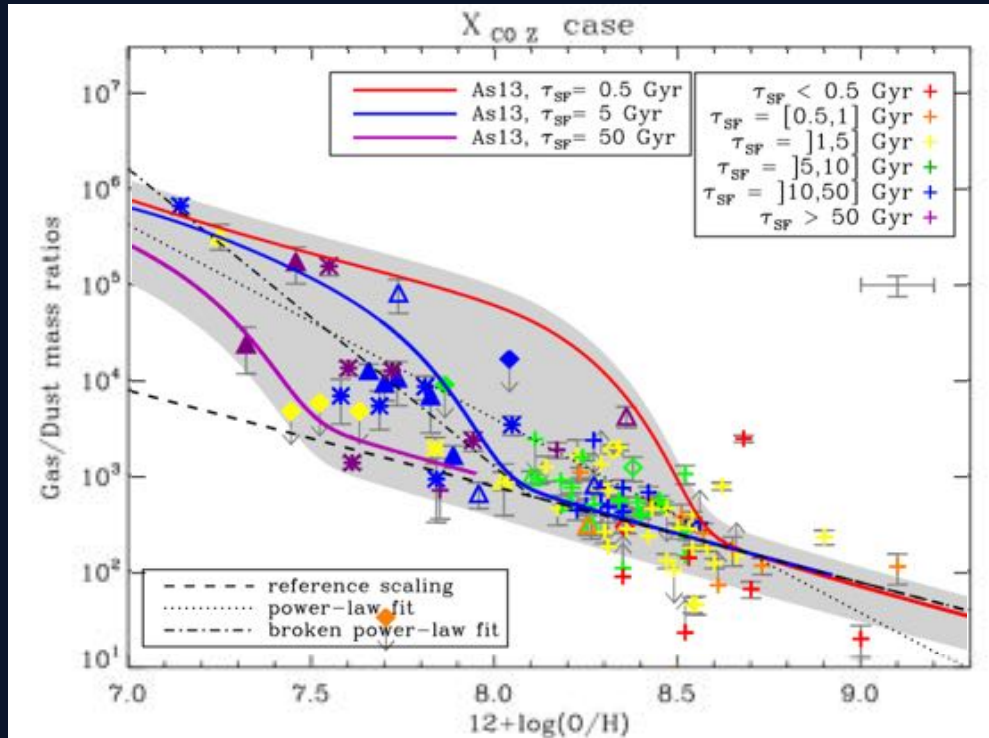


Aggregates with ice mantle



GAS-TO-DUST MASS RATIO EVOLUTION

Evolution of the ratio with metallicity



Chemical Evolution models from Asano et al (2013a)

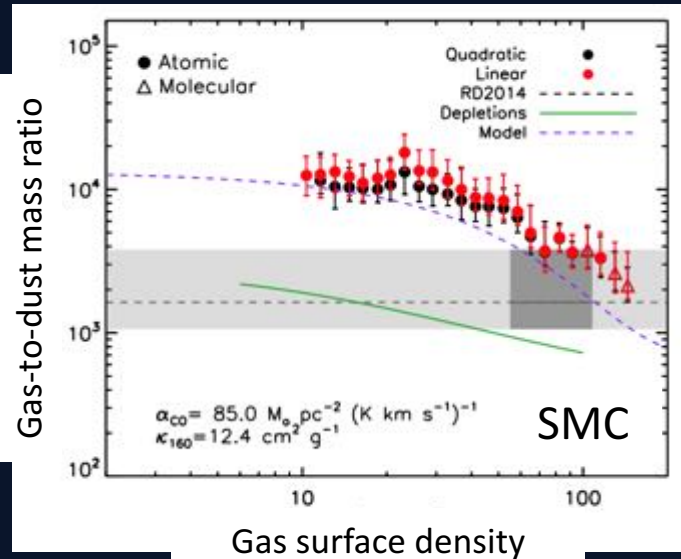
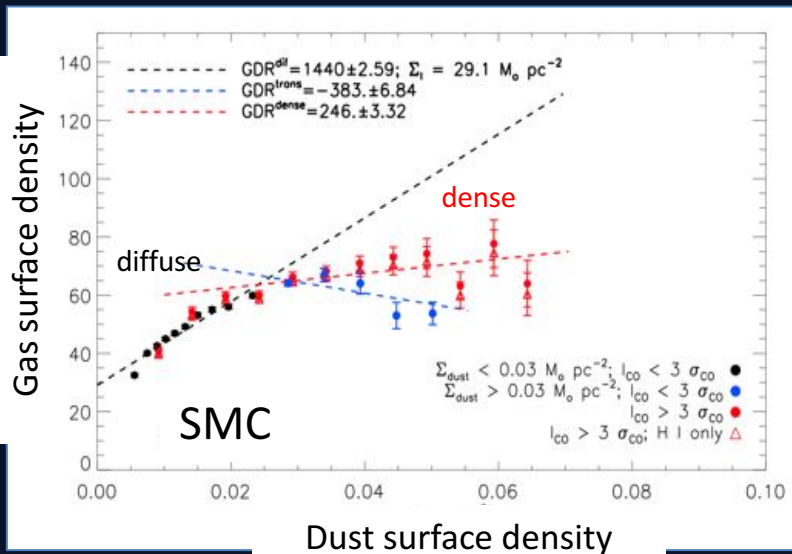
The trend can be explained when **grain growth** in the ISM is taken into account in the dust formation processes.

Rémy-Ruyer et al, 2014

SIGNATURES OF DUST EVOLUTION IN THE MAGELLANIC CLOUDS

Variations in the Gas-to-Dust ratio with the environment

- Decrease of G/D from the diffuse ISM to the dense clouds



TAKE-HOME MESSAGES AND FUTURE

Need of refined / rescaled dust properties to fit the submm observations

Signs of dust properties variations from diffuse to dense medium

Spatially resolved studies : ALMA, JWST

→ dust heating in dense extragalactic PDRs

FIR spectroscopy: SPICA

→ better constraint on the shape of the SED

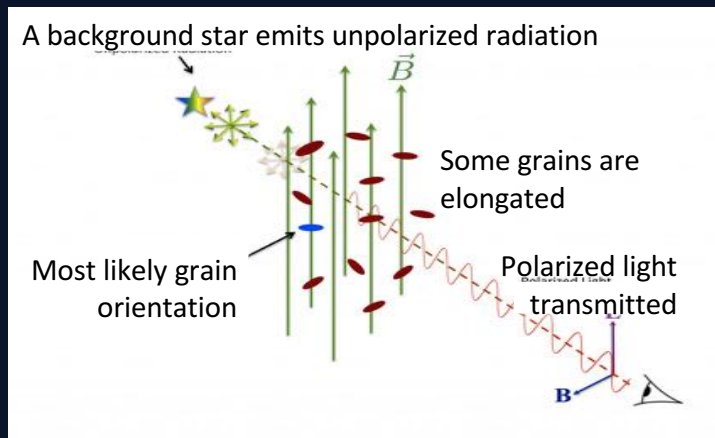
→ IR polarimetry

Next tool to investigate the dust composition:

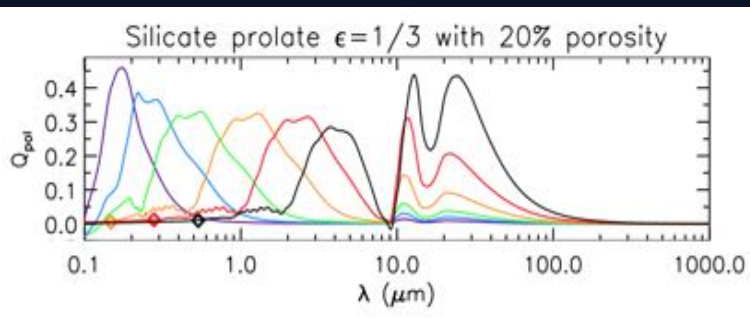
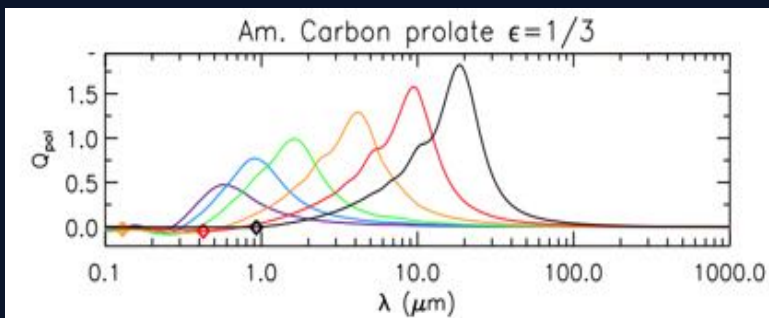
modelling the **polarized dust emission**

DUST POLARISATION

A strong **diagnostic tool**
to probe the
composition



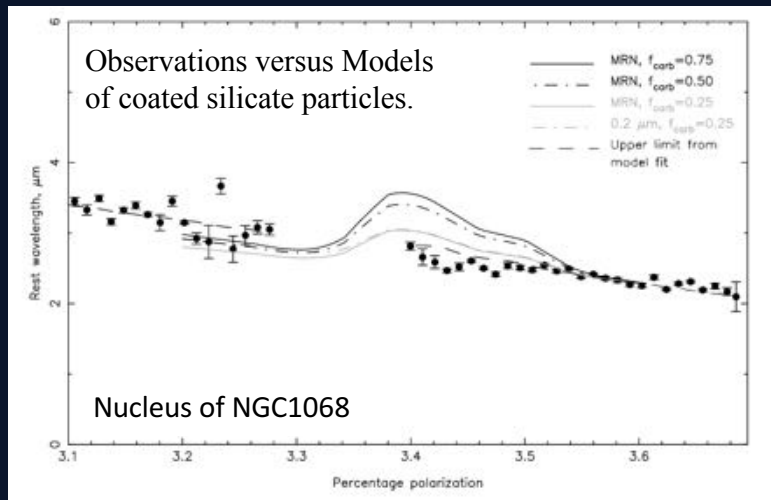
Polarization depends on the alignment degree and grain structure



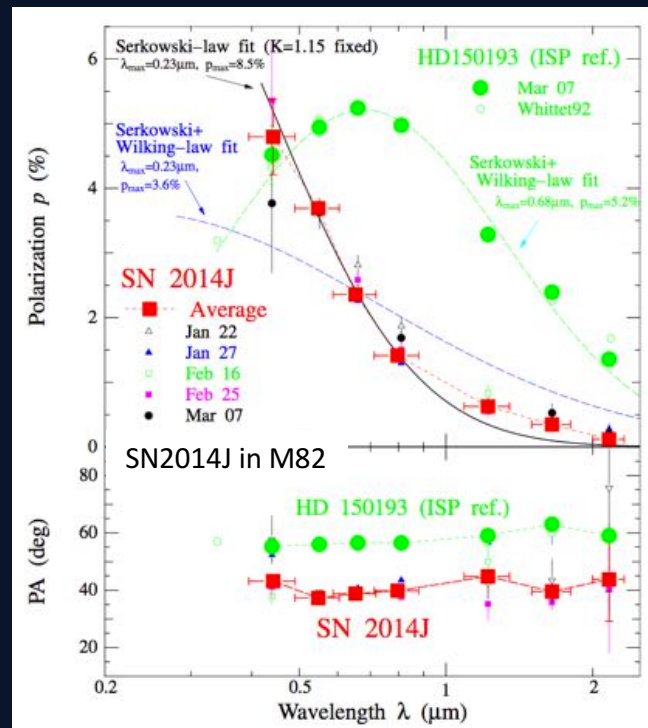
Guillet et al (2017)



DUST POLARISATION IN NEARBY GALAXIES



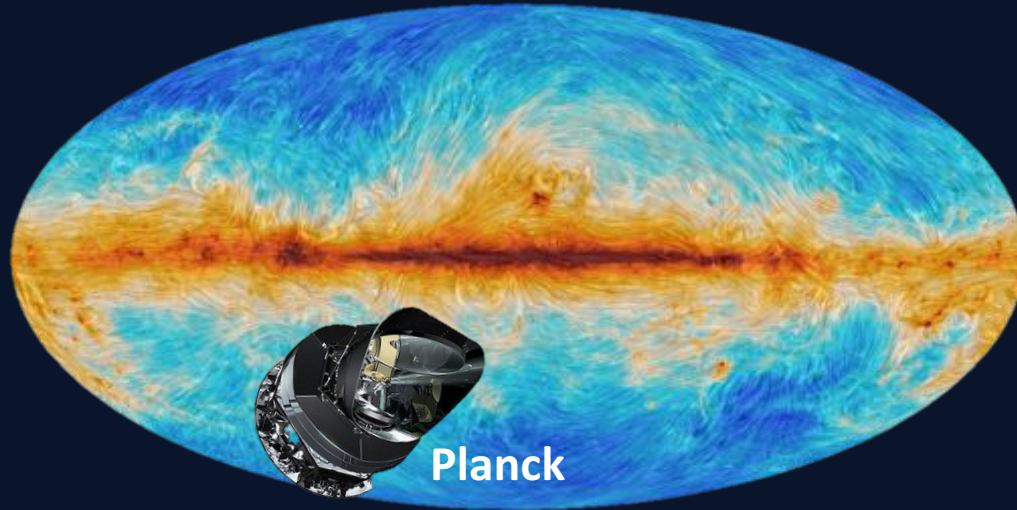
Mason et al 2007



Kawabata et al 2014

A GOLDEN AGE FOR DUST POLARIMETRY

The arrays



Instruments



Balloon exp.
BLASTPol,
PILOT

In space?
POL on SPICA

SMA



EVLA



ALMA



SKA

