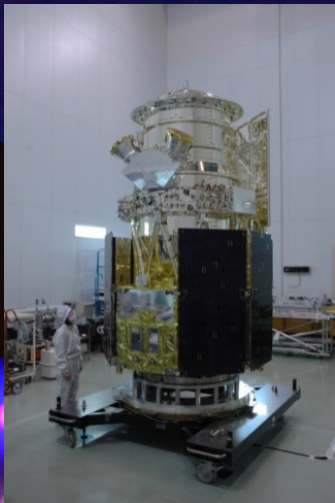


SPiCAが狙うサイエンス (3) 宇宙の物質循環

金田 英宏 (名古屋大学)、SPiCAサイエンスWG
天文学会SPiCA特別セッション

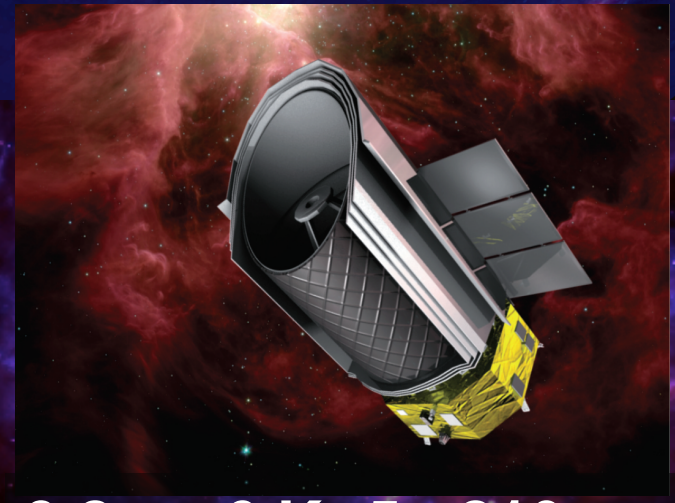
AKARI (Feb, 2006)



0.7 m, 6 K、2 - 180 μm



SPiCA (2022)



3.2 m, 6 K、5 - 210 μm

宇宙初期のダストから現在の惑星形成まで、
固体物質進化の全ストーリーを解き明かす

SPICAが見る物質とは？

宇宙赤外線観測は、「**固体微粒子**」(ダスト)が主役

(1) 放射エネルギーのピークが**中遠赤外線帯**

(2) 固体スペクトルフィーチャはbroad:

連続的な波長カバレッジ、かつ、**低背景が重要**

(3) 多くの**固体振動**モードが中遠赤外線帯に存在:

とくに、**silicate (Si-O)**と**organic matter (C-C、C-H)**

(4) 励起エネルギー源が必要(物質温度 \sim **100 K**)。

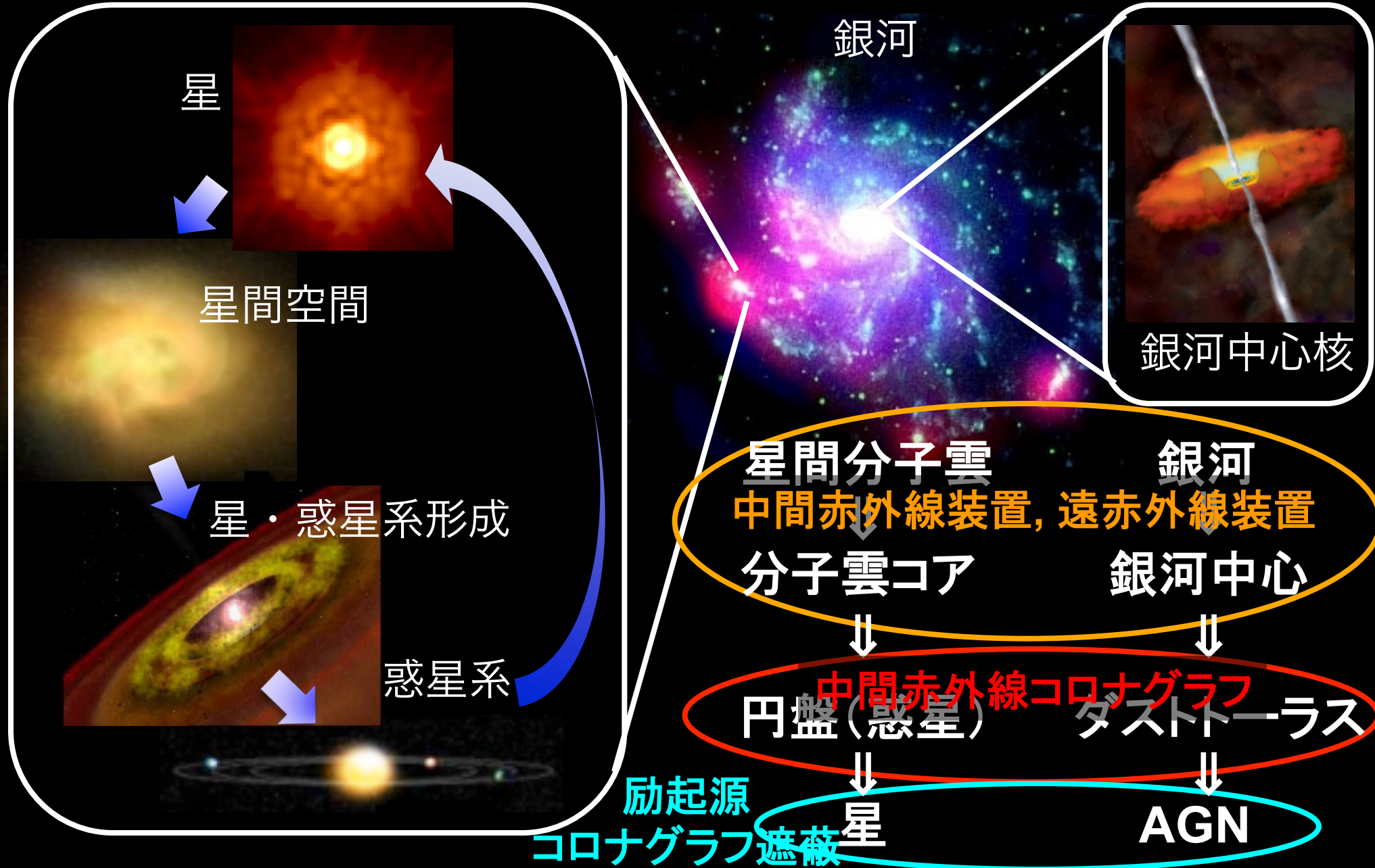
⇒ **星周、銀河核周** ⇒ **高空間分解能**

従来: 赤外線光度 ⇒ 現在の熱量 ⇒ 星形成率

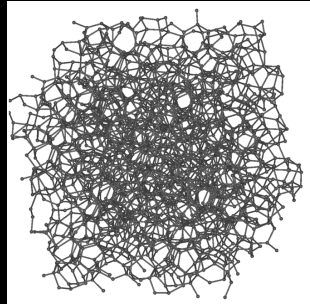
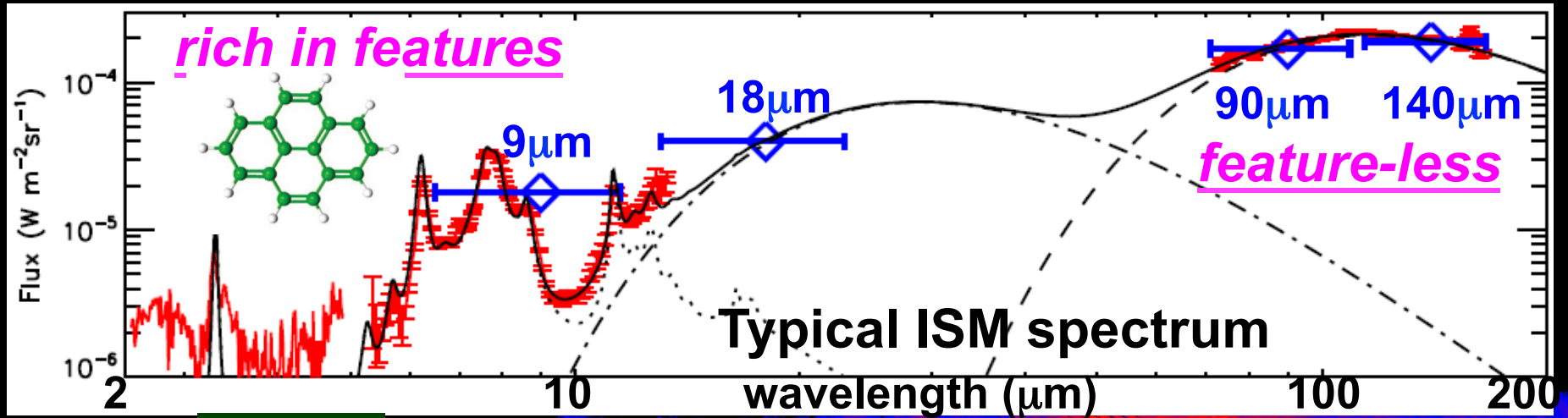
SPICA: スペクトル ⇒ 過去の熱・化学環境 ⇒ 惑星系・銀河史



物質の循環と進化

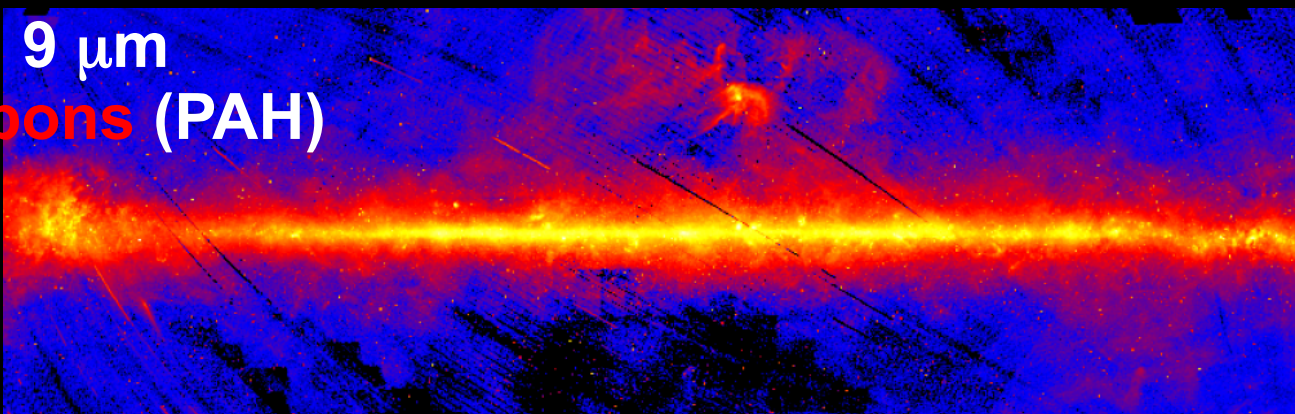
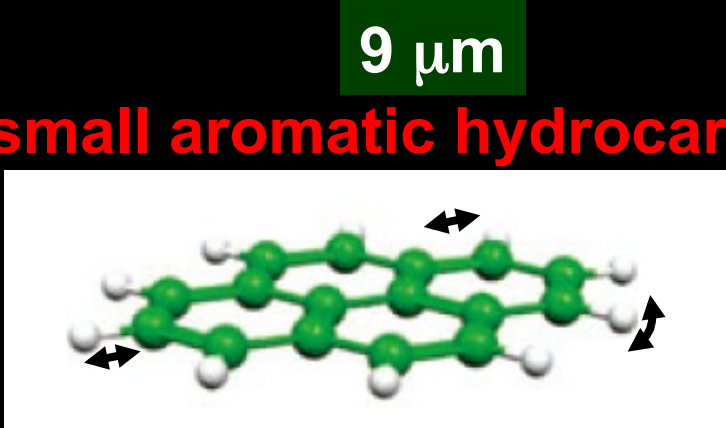
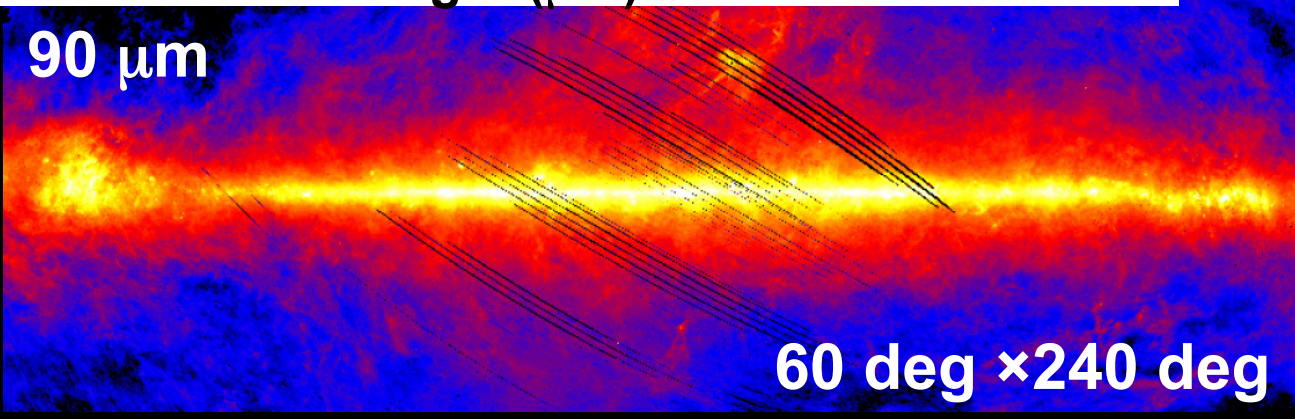


「あかり」で得られた星間物質の分布とスペクトル

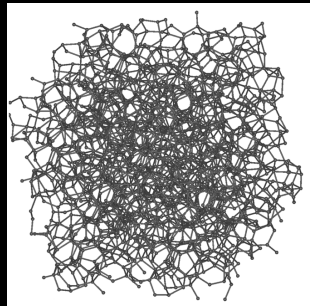
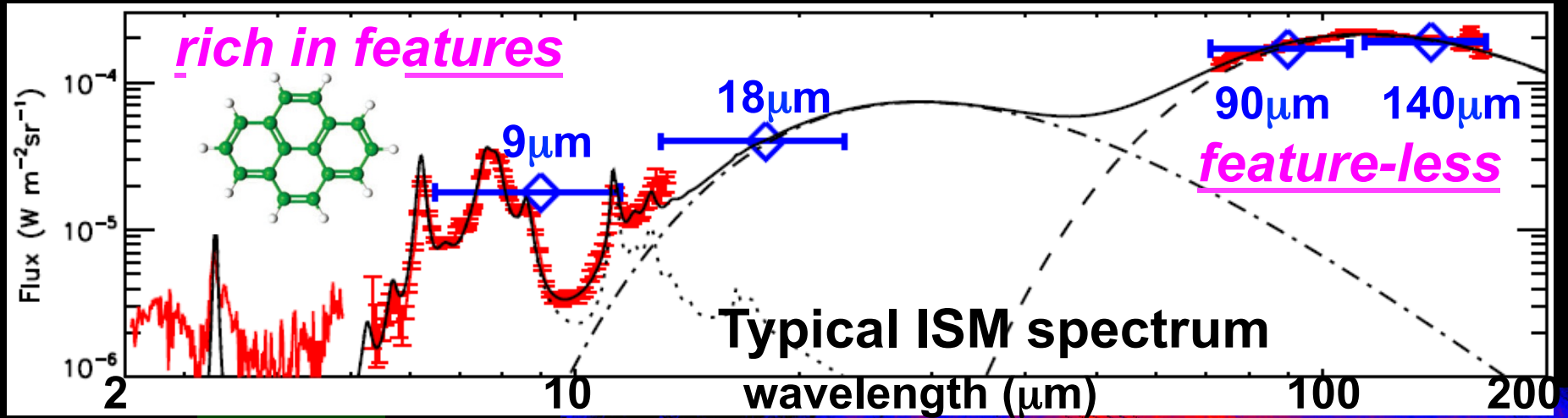


90 μm

large
amorphous
grains

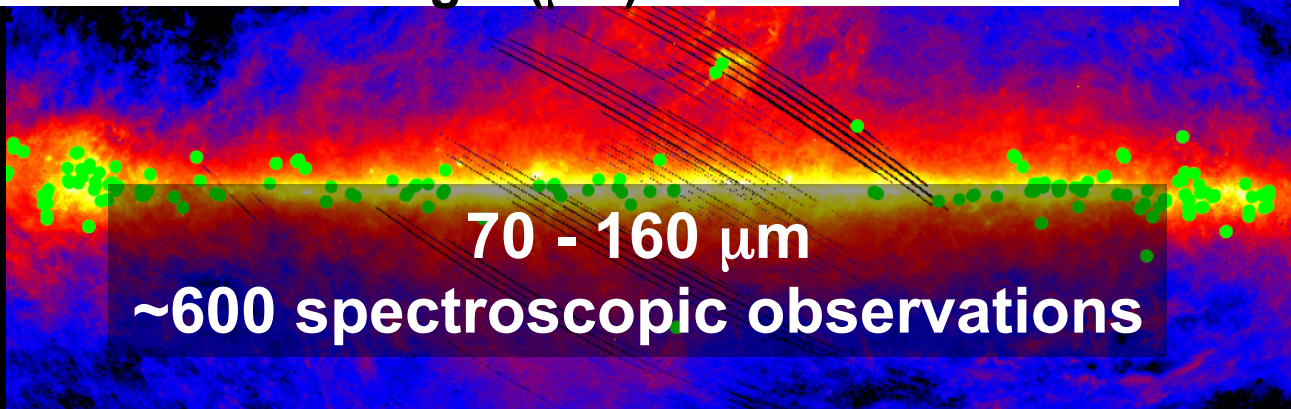


「あかり」で得られた星間物質の分布とスペクトル



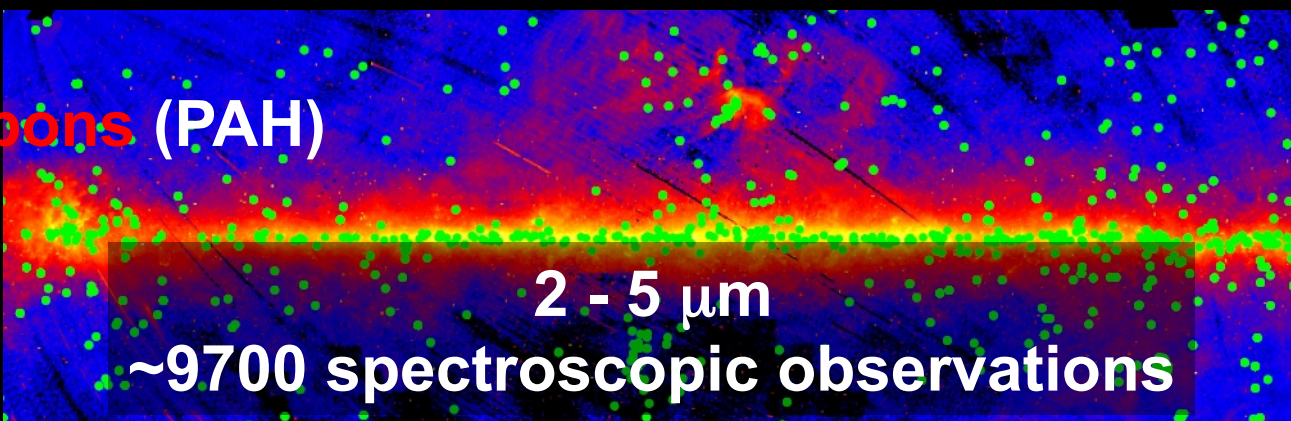
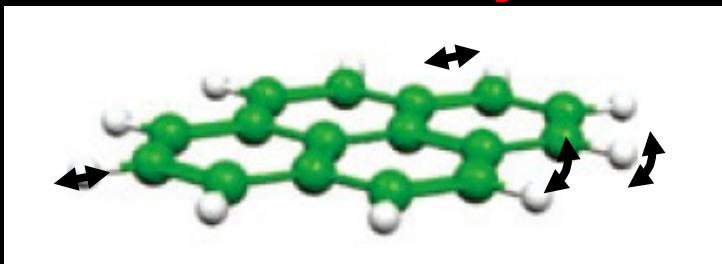
90 μm

large
amorphous
grains

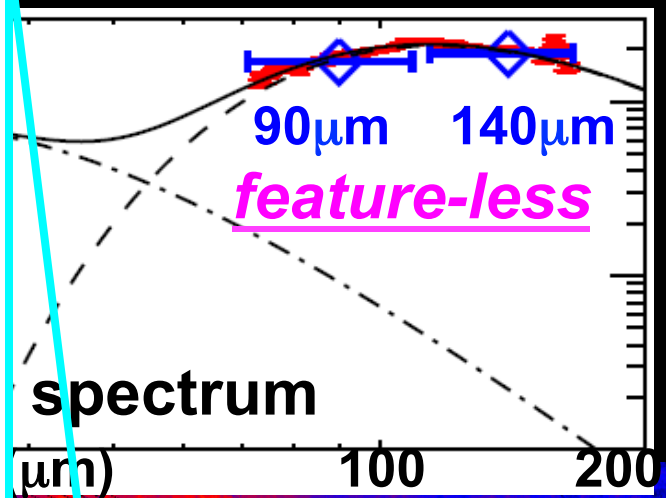
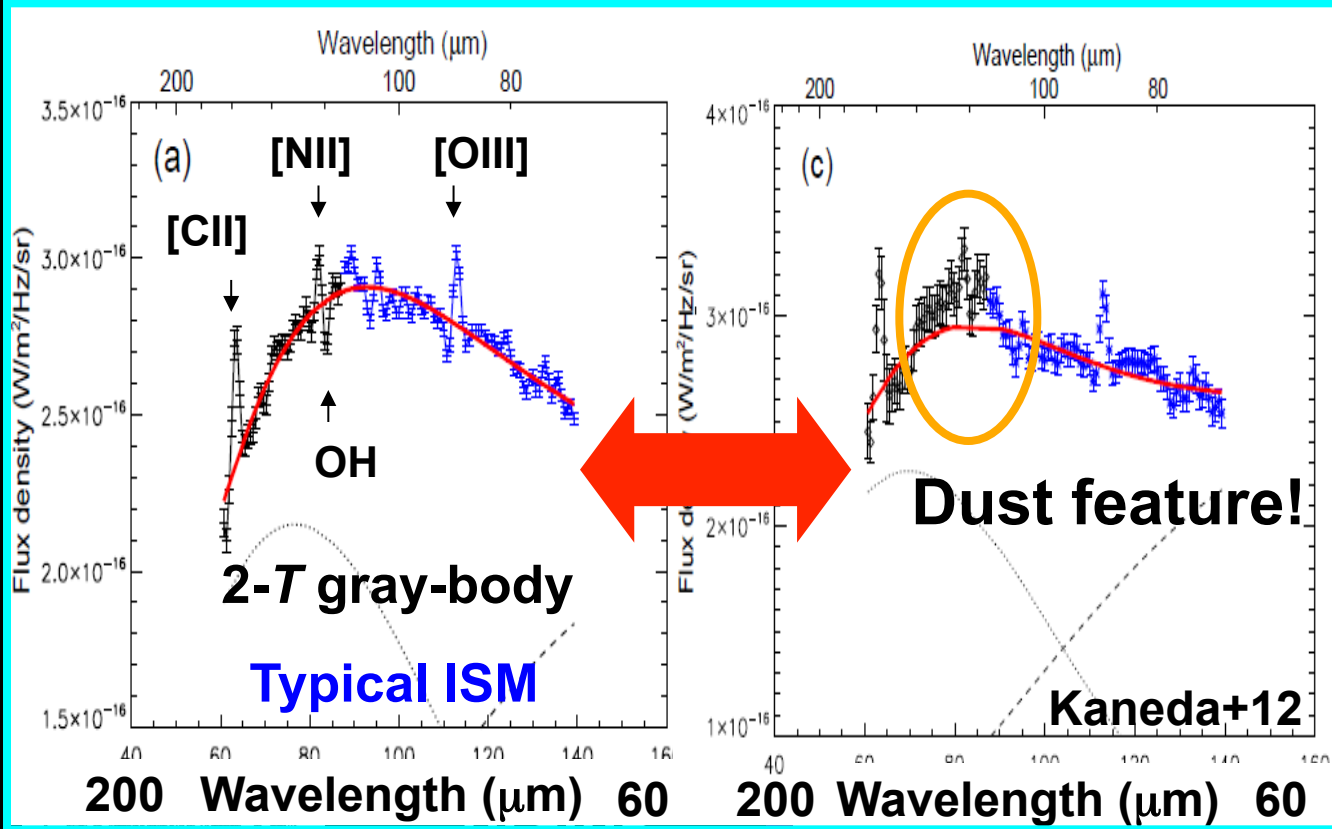


9 μm

small aromatic hydrocarbons (PAH)



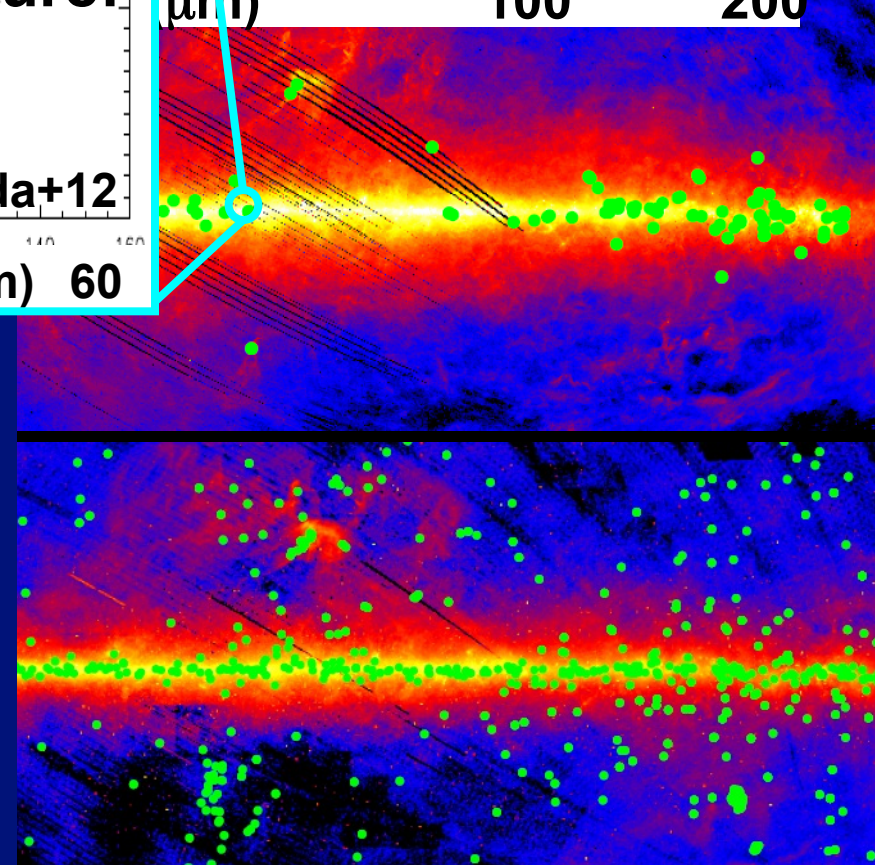
「ちか山」で得られた目黒物質の分布とスペクトル



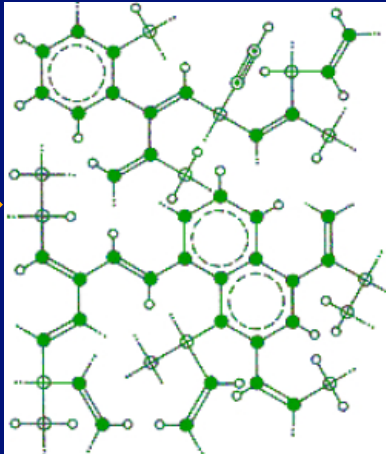
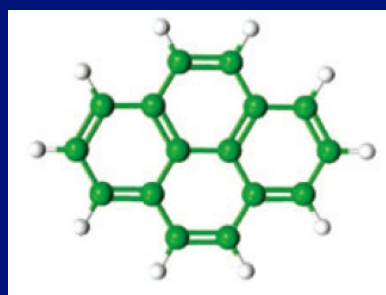
Formation of graphite in G.C.
Annealing at $\sim 3000\text{ K}$ needed.

small

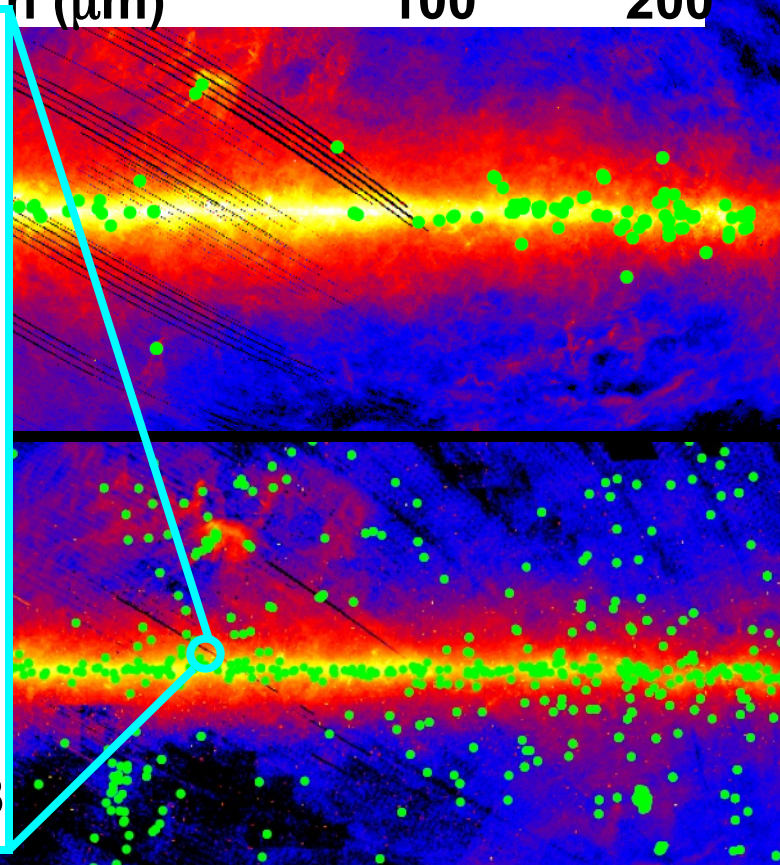
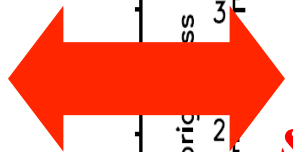
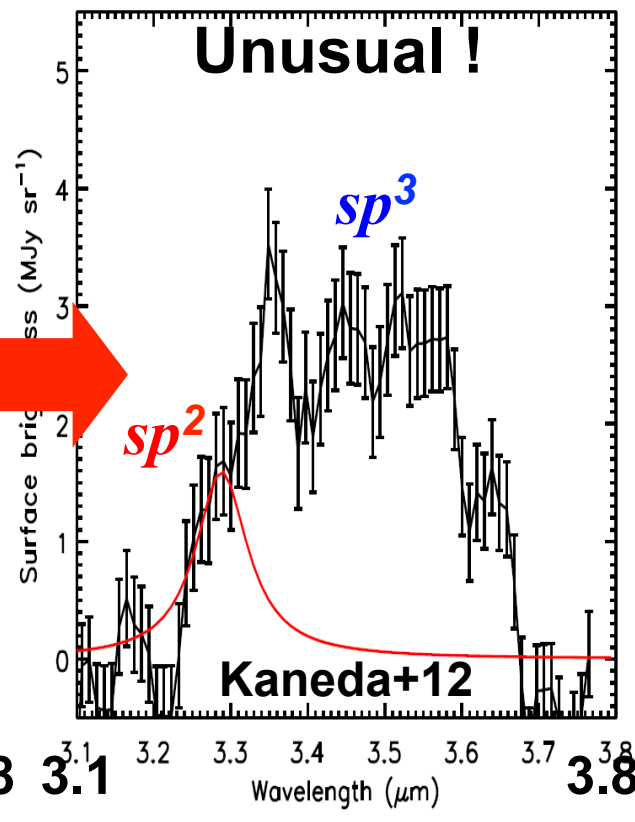
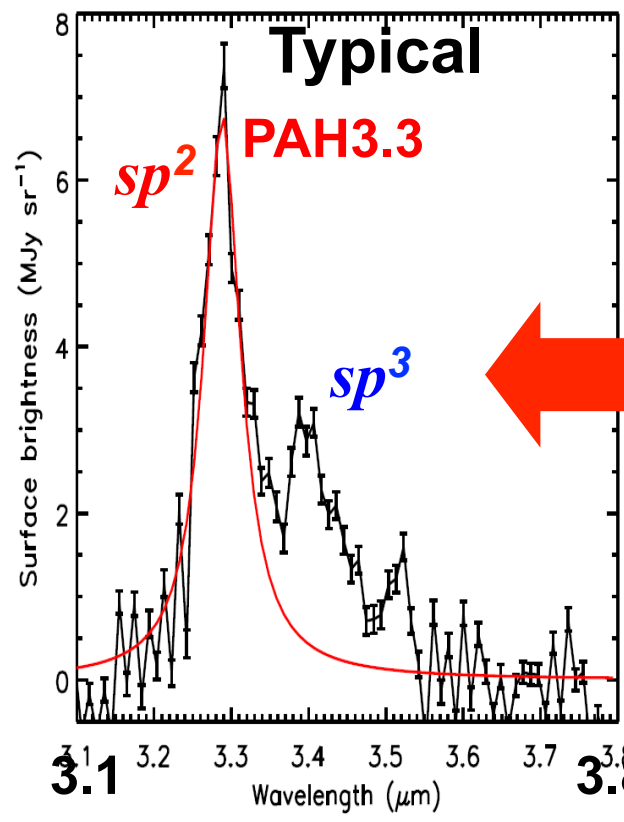
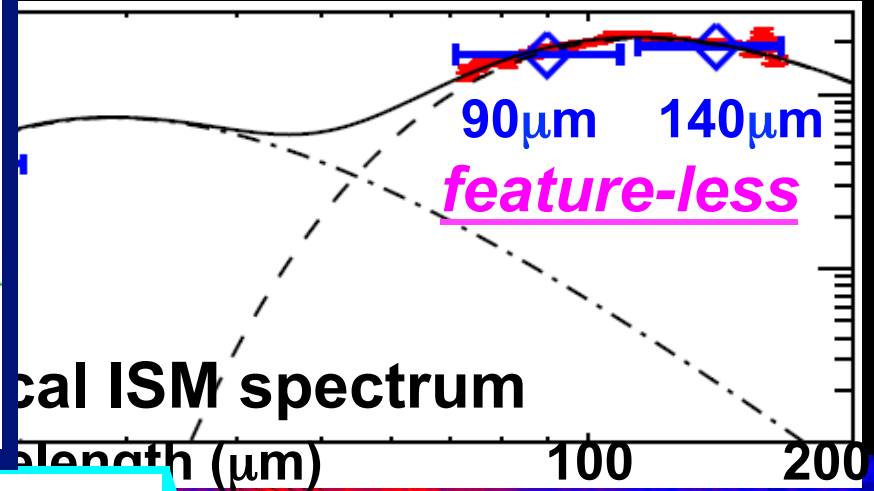
→ the (past) activity of Sgr A*?



Processing of hydrocarbons



→ shattering?



宇宙における炭素質固体微粒子の進化

AKARI 24 μm
Arimatsu+11

Ishihara+11

mass loss from C stars

Carbon star distributions

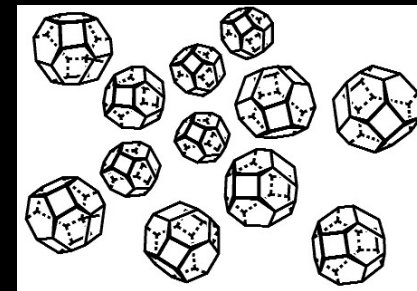
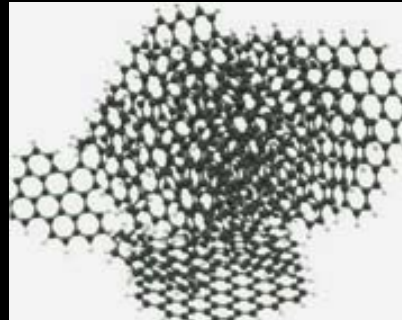
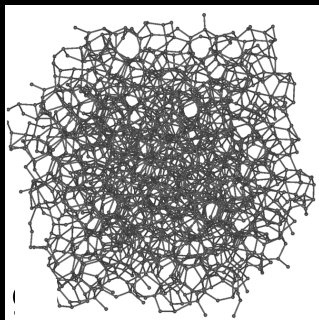
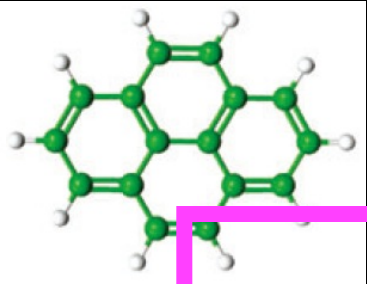
C atoms

amorphous

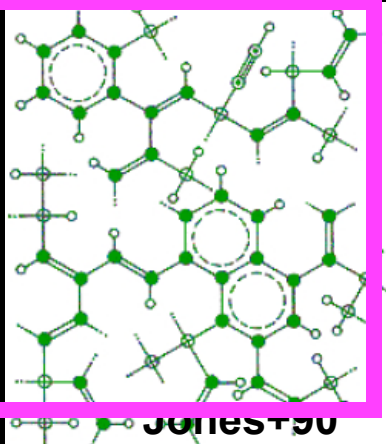
graphite

diamond

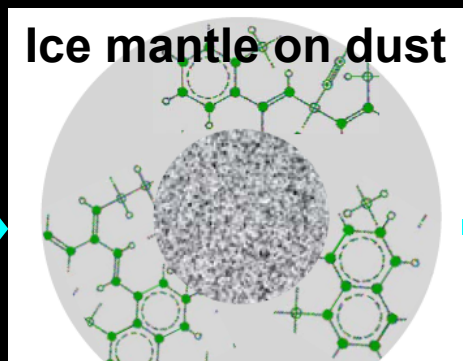
PAHs



Structural changes



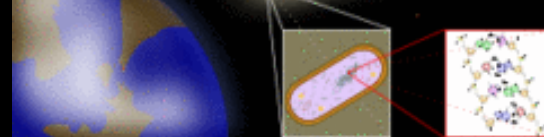
Ice mantle on dust



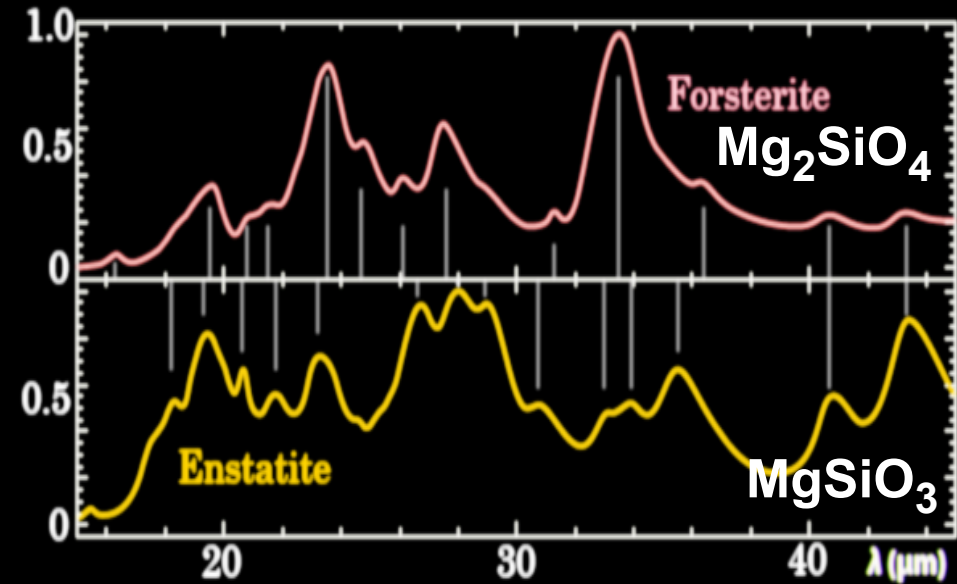
Organic compounds

Meteorites on planets

Pre-biotic



宇宙鉱物学から惑星系形成・銀河進化史を探る



シリケート15~45 μm スペクトル

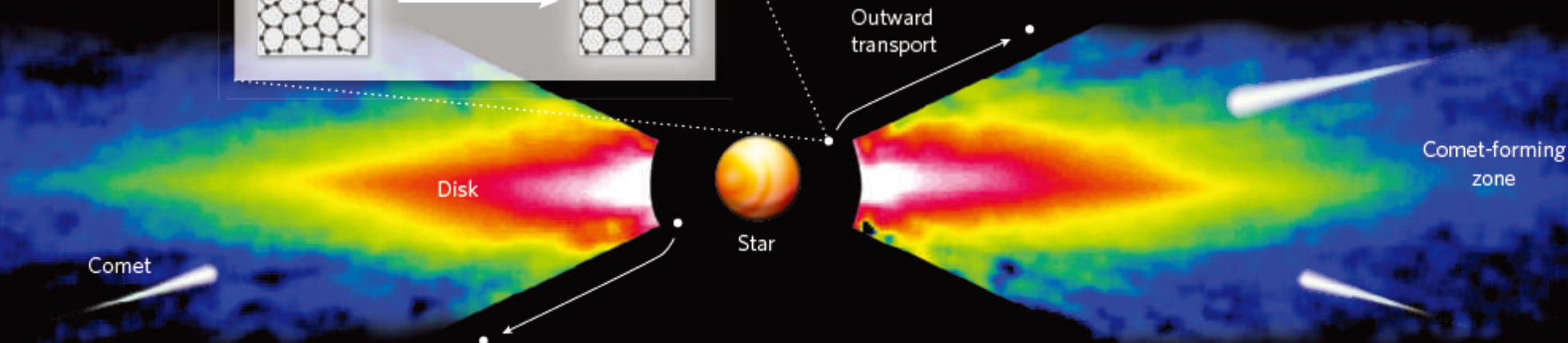
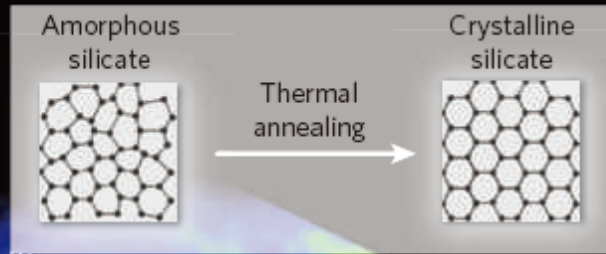
Amorphous? \Leftrightarrow Crystalline?
(高温アニーリング)

Olivine? \Leftrightarrow Pyroxene?
($\text{Mg}_{2-2x}\text{Fe}_{2x}\text{SiO}_4$) ($\text{Mg}_{1-x}\text{Fe}_x\text{SiO}_3$)
(熱負荷の総量)

Mg-rich? \Leftrightarrow Fe-rich?
(微粒子生成時の金属量環境)

・惑星系形成の熱史、惑星の原料
・AGN活動史、銀河の化学進化

Li 2009



まとめ

・宇宙赤外線観測は、「**固体微粒子**」(ダスト)が主役

・「あかり」は、微粒子(とくに有機物PAH)の**全天分布**を明らかにした。スペクトル観測は、星周で作られた微粒子が**変遷**を経て、**星間空間で変性・進化**する様子の一部を捉えた。

・**固体振動のフルレンジ分光観測**により、宇宙の鉱物学、有機物質進化化学を展開。将来の惑星系形成論・銀河進化史への新たな切り口になる。

・**高い空間解像度**によって、とくに物質進化の行き着く先(惑星系・AGNトラスの材料など)を捉え、**固体物質進化の全ストーリー**を明かす。

宇宙における炭素質固体微粒子の進化

AKARI 24 μm
Arimatsu+11

Ishihara+11

mass loss from C stars

Carbon star distributions

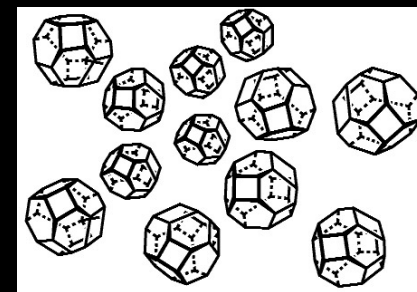
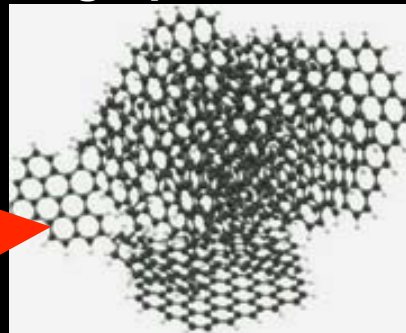
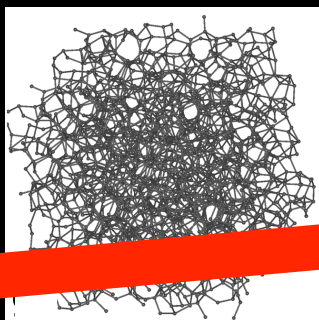
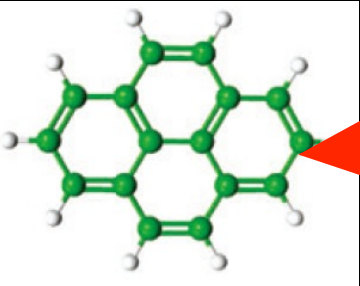
C atoms

amorphous

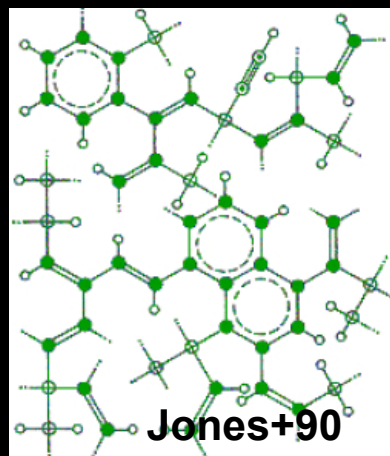
graphite

diamond

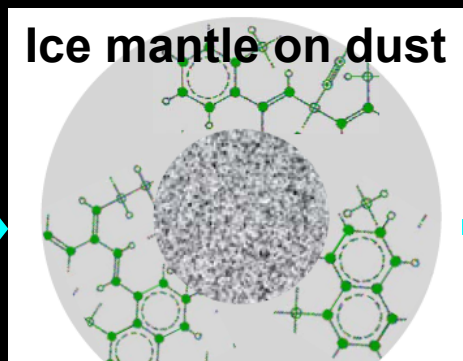
PAHs



Structural changes



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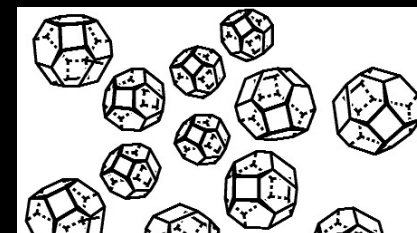
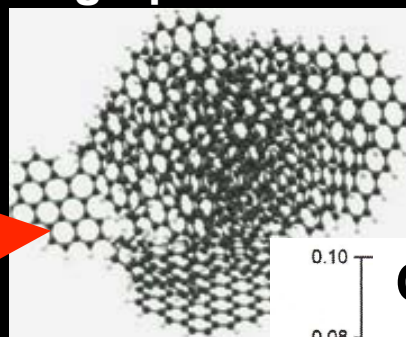
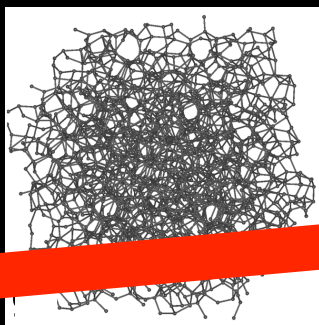
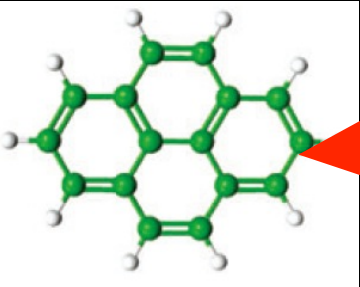
C atoms

amorphous

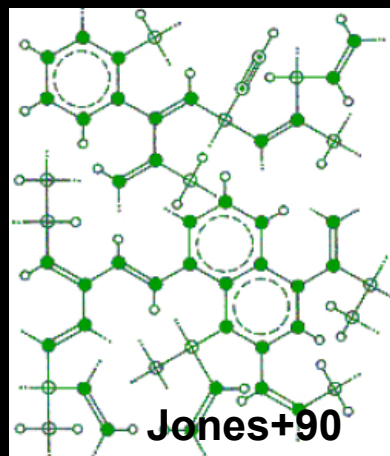
graphite

diamond

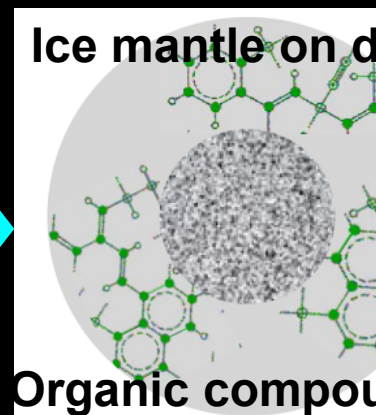
PAHs



Structural changes



Ice mantle on d



Cometary PAHs

