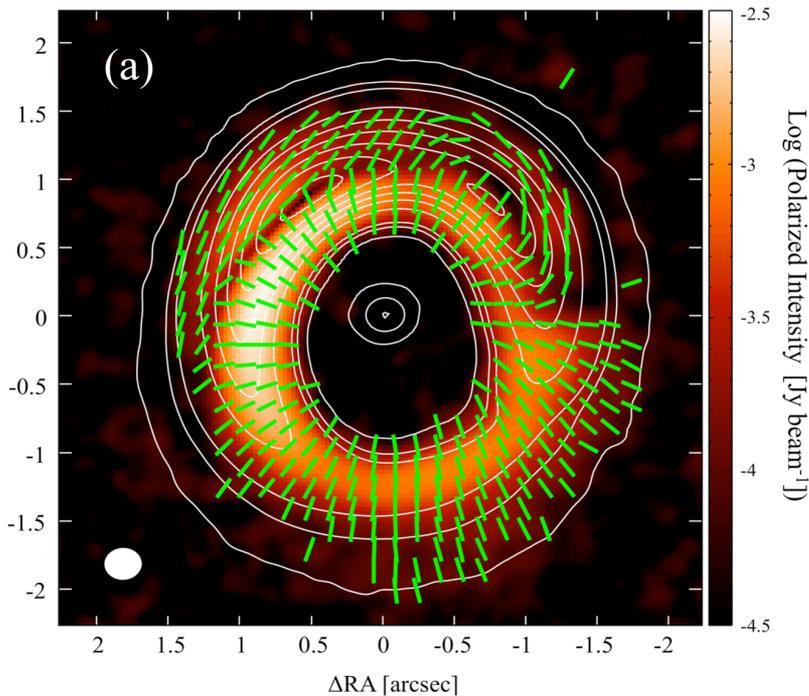
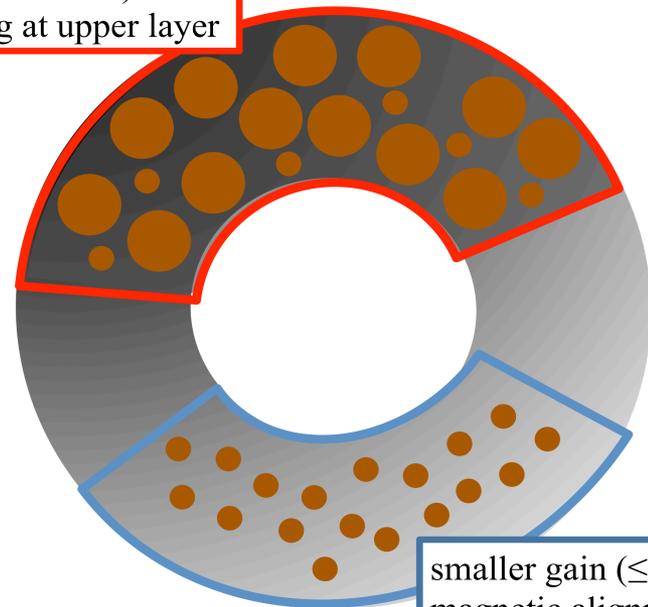


多波長偏光観測で調べる原始惑星系円盤 のダスト分布

大橋聡史(理研)



larger gain ($\geq 150 \mu\text{m}$)
self-scattering at upper layer



smaller gain ($\leq 100 \mu\text{m}$)
magnetic alignment

円盤のサイエンスからの提言



- 10 au以下のスケールを「光学的に薄く」見通したい

分解能 $\sim 0.0X''$ at 100 pc
波長 $> \text{mm}$

- mm-cm 帯で偏光観測を行いたい

分解能 $\sim 0.X''$ at 100 pc
波長 $> \text{mm-cm}$
感度 $< \mu\text{Jy beam}^{-1}$

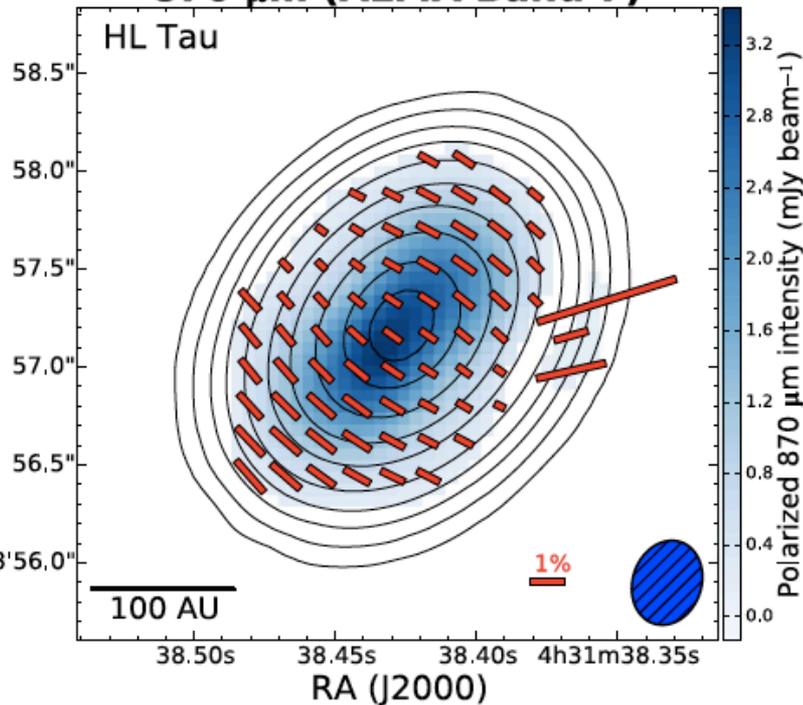
ngVLAを使いたい

※個人の意見です

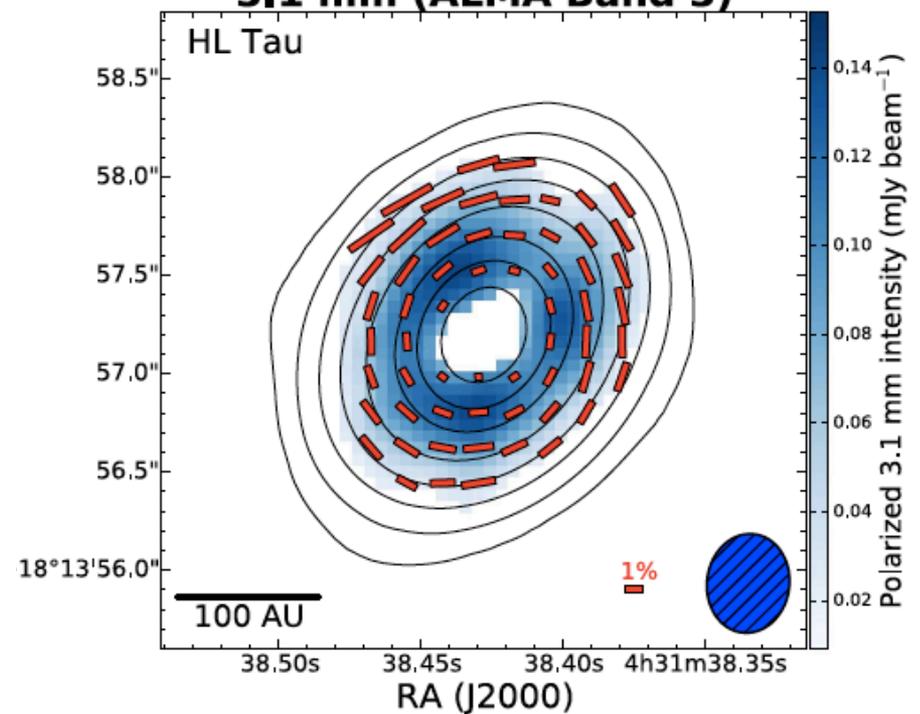
ALMA polarization in protoplanetary disks



870 μm (ALMA Band 7)

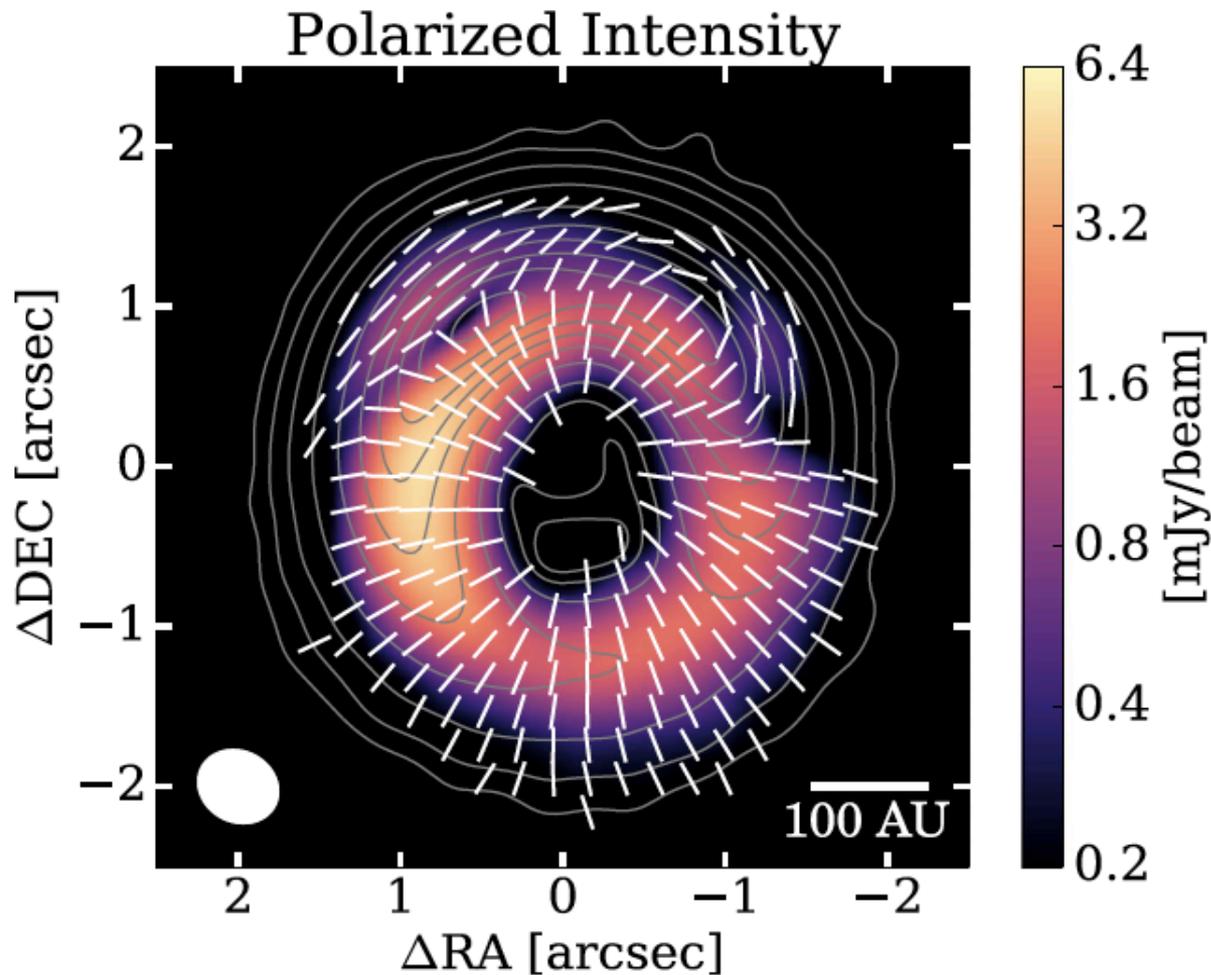


3.1 mm (ALMA Band 3)



Stephens+18, Kataoka+17

ALMA polarization in protoplanetary disks



HD 142527

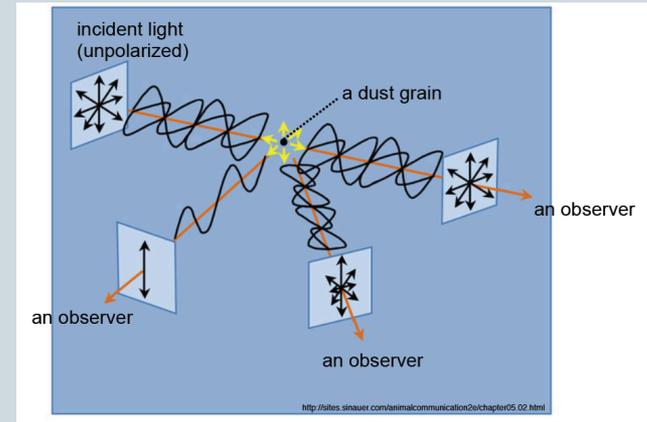
Kataoka+16

mechanisms of polarization in disks



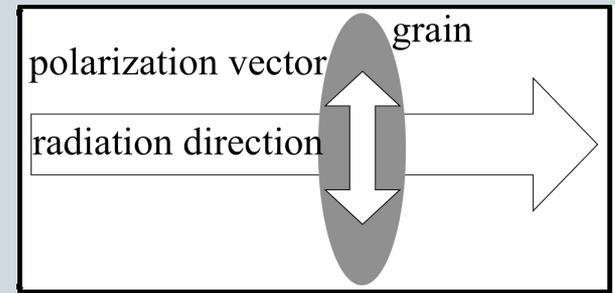
- 1. ダストの熱放射による **自己散乱**

e.g., Kataoka et al. 2015,
Yang et al. 2016, Pohl et al. 2016



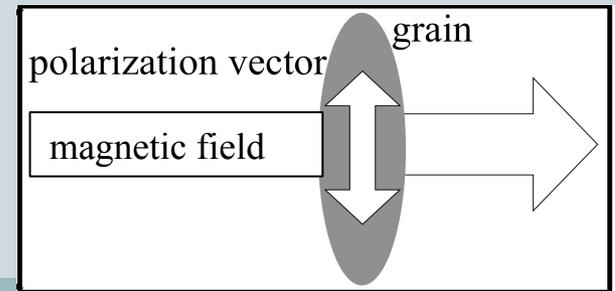
- 2. 輻射場に沿った **ダスト整列**

e.g., Tazaki et al. 2017



- 3. 磁場に沿った **ダスト整列**

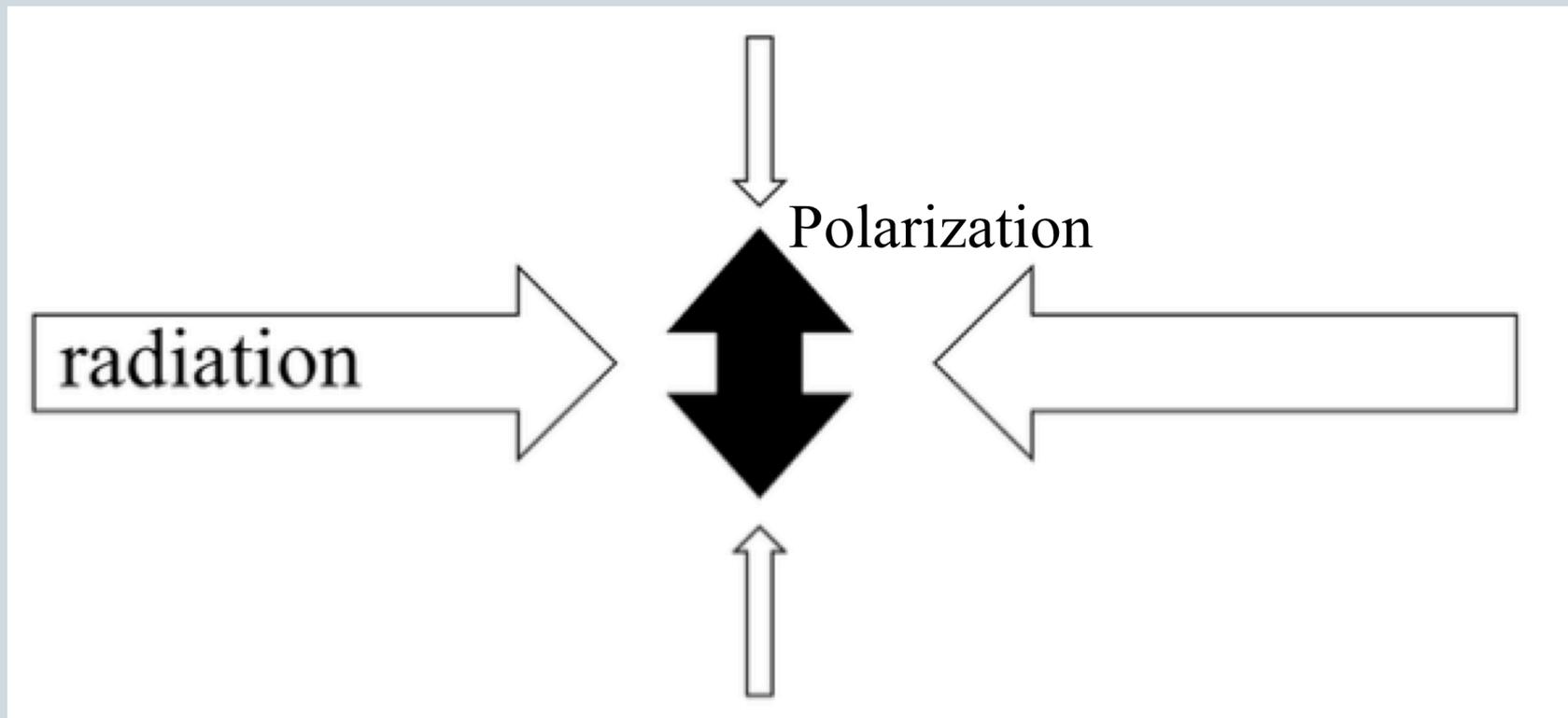
e.g., Cho & Lazarian et al. 2007



Polarization by self-scattering



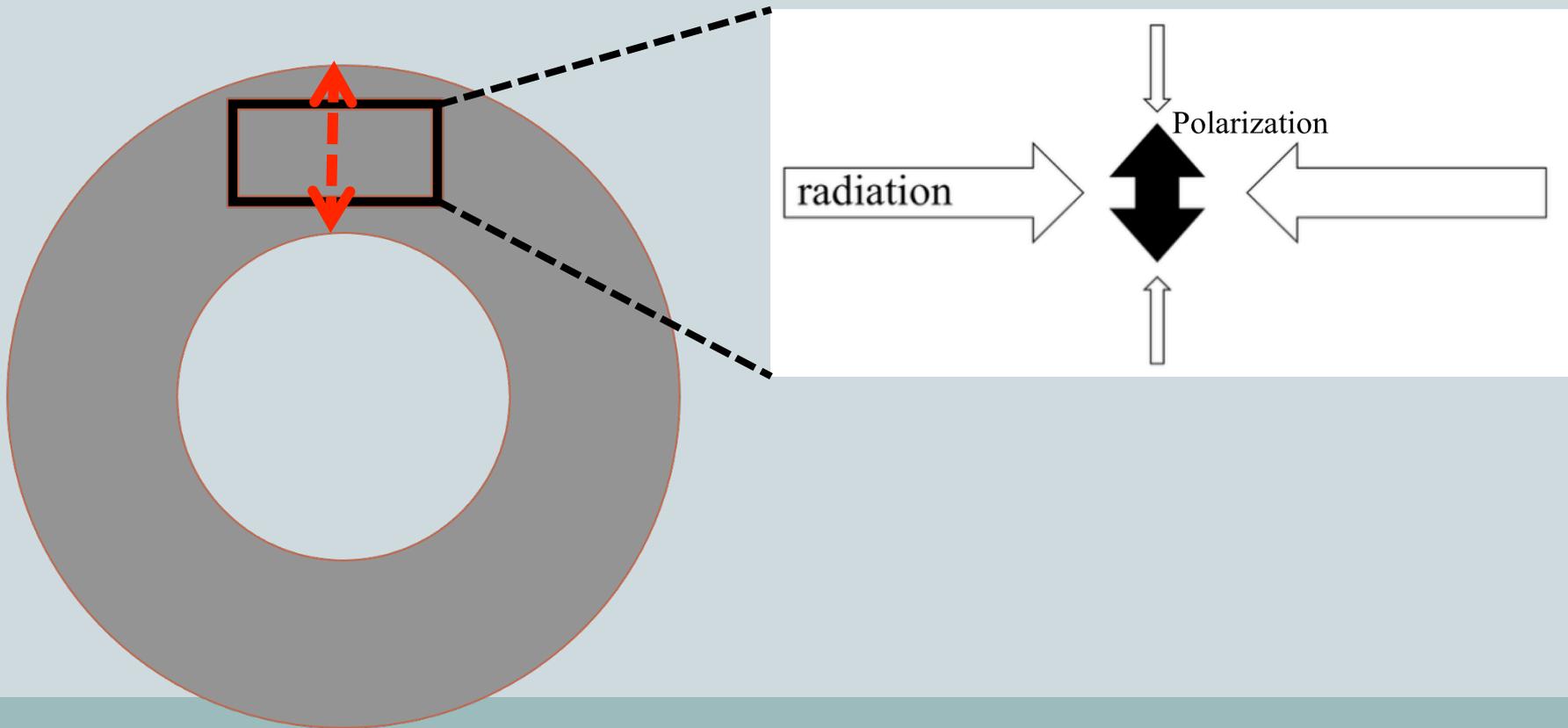
If dust size becomes larger and the scattering opacity increases, the polarization is produced by anisotropic radiation



Polarization by self-scattering



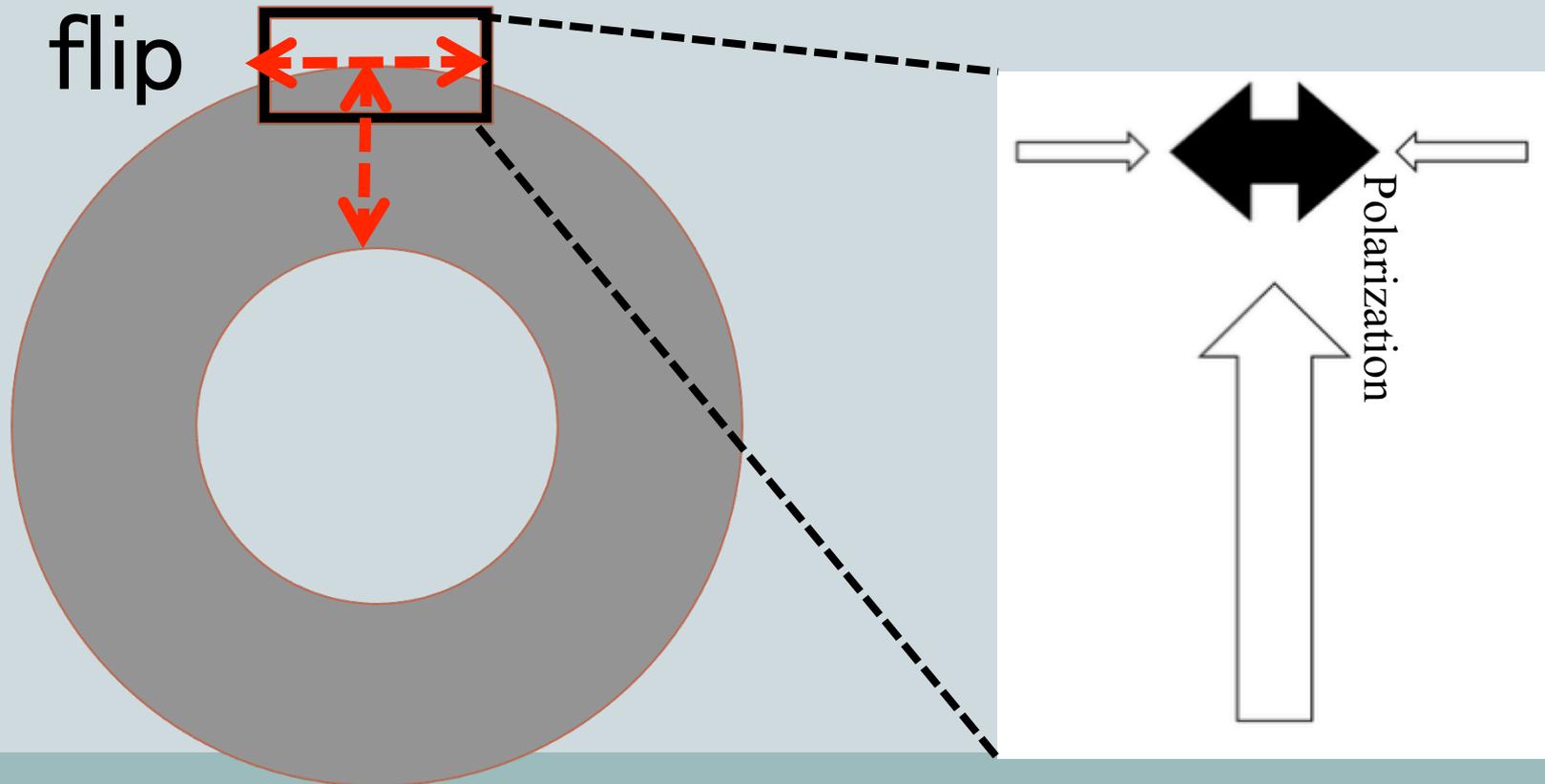
If dust size becomes larger and the scattering opacity increases, the polarization is produced by anisotropic radiation



Polarization by self-scattering



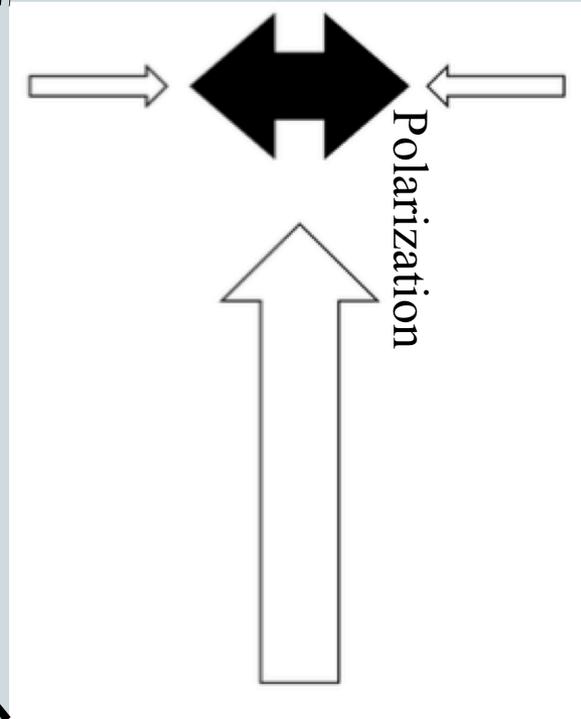
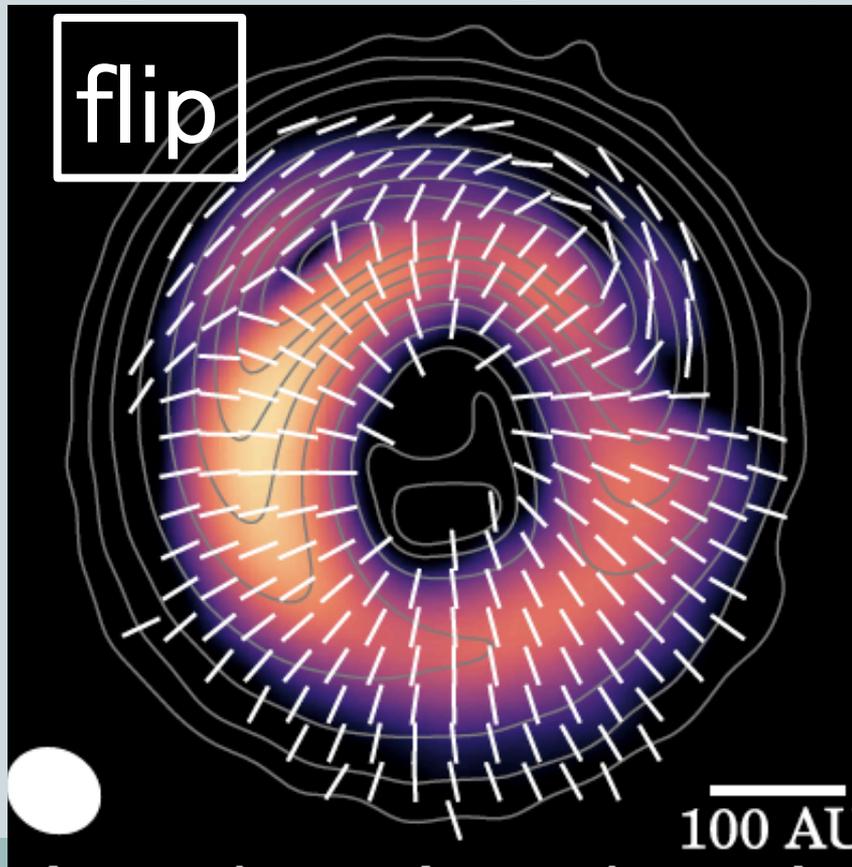
If dust size becomes larger and the scattering opacity increases, the polarization is produced by anisotropic radiation



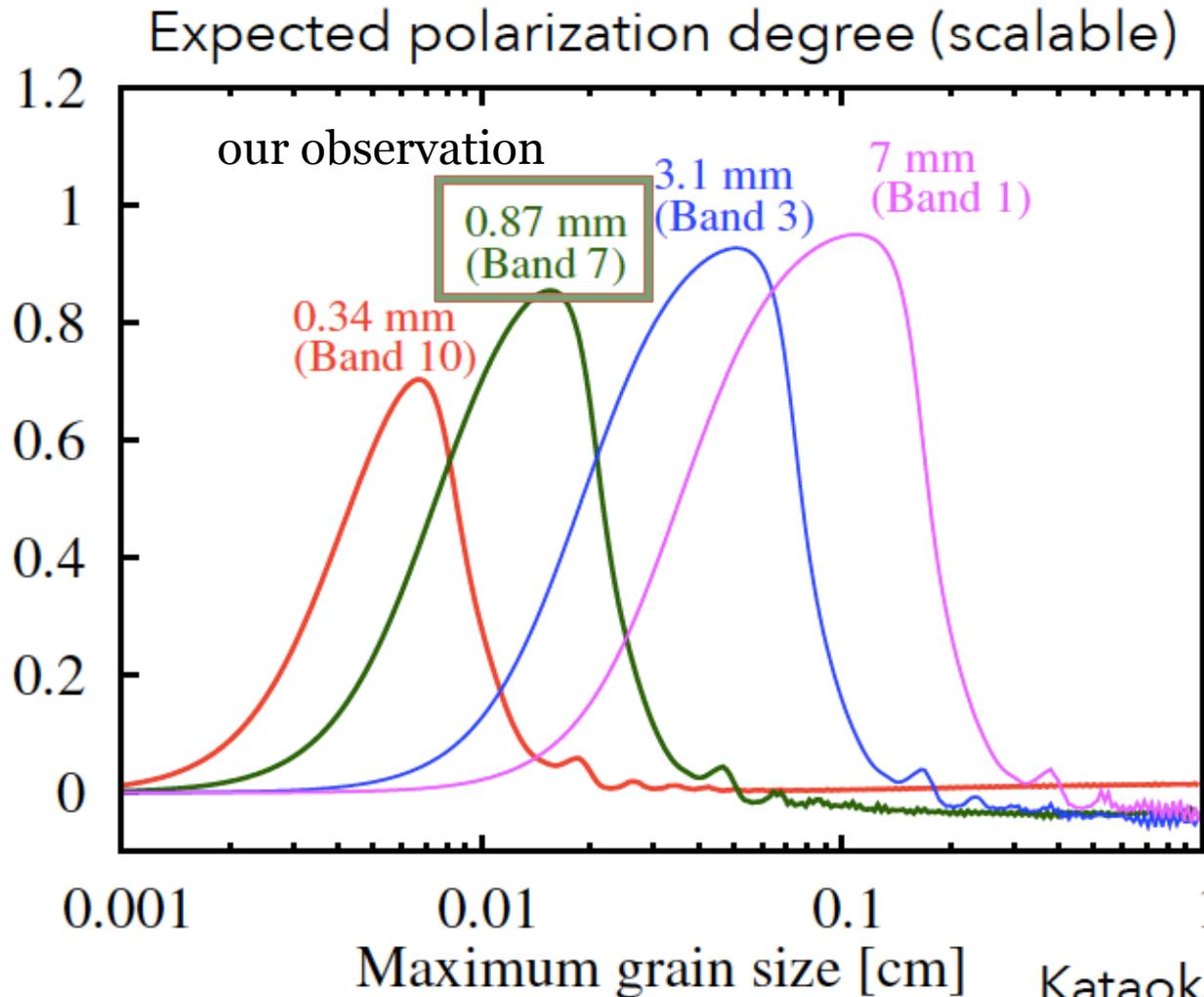
Polarization by self-scattering



If dust size becomes larger and the scattering opacity increases, the polarization is produced by anisotropic radiation



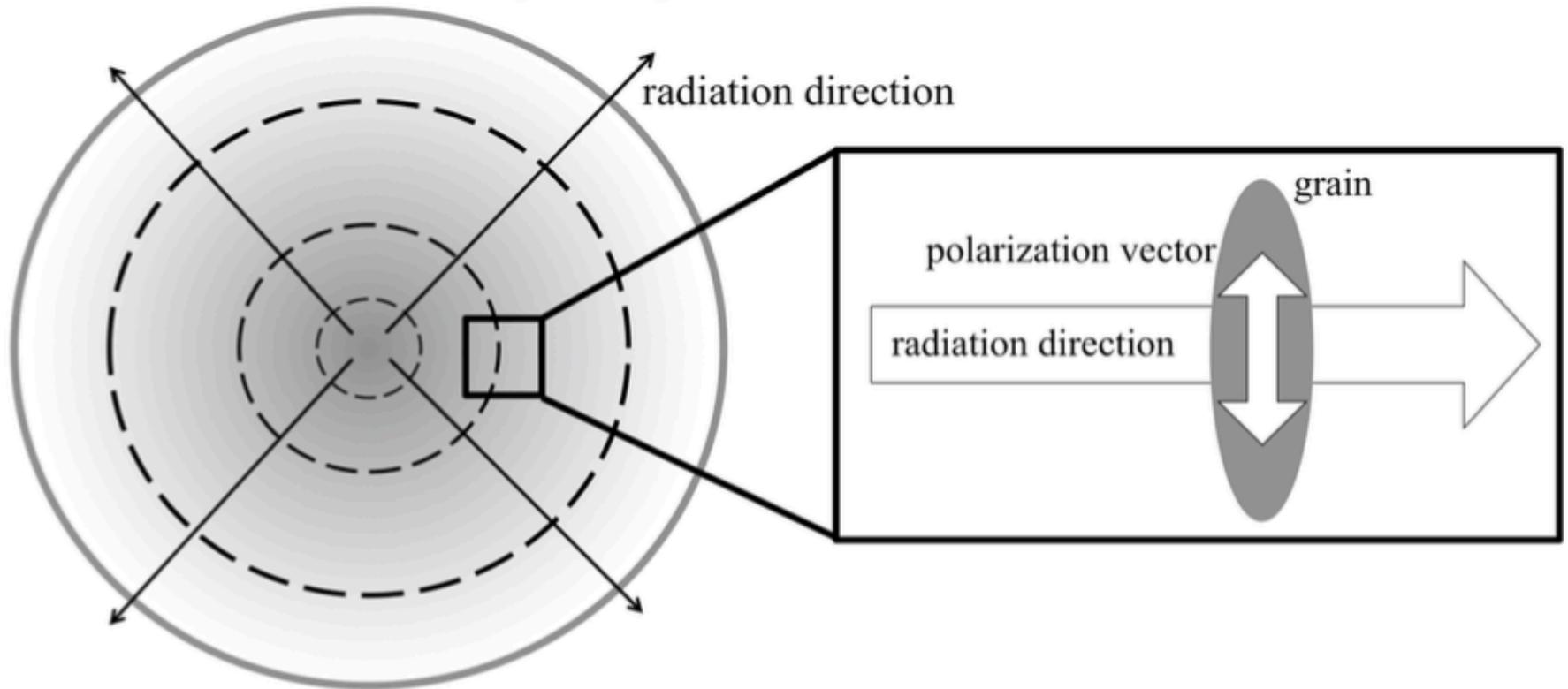
Dust size prediction from polarization



Radiative grain alignment



Polarization with radiative grain alignment

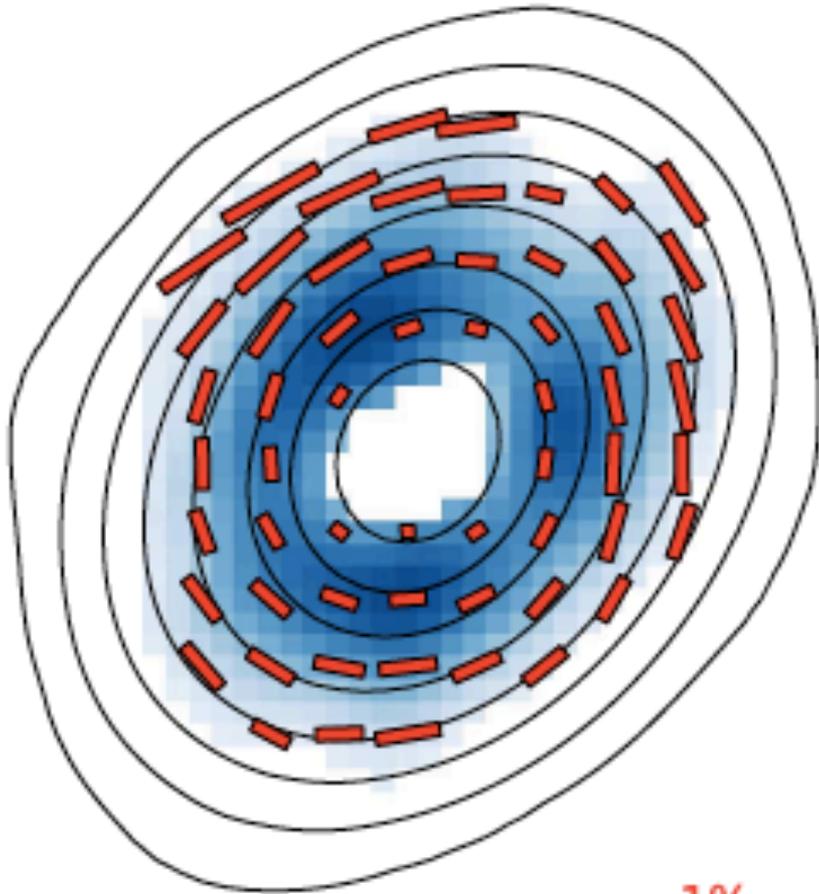


Radiative grain alignment

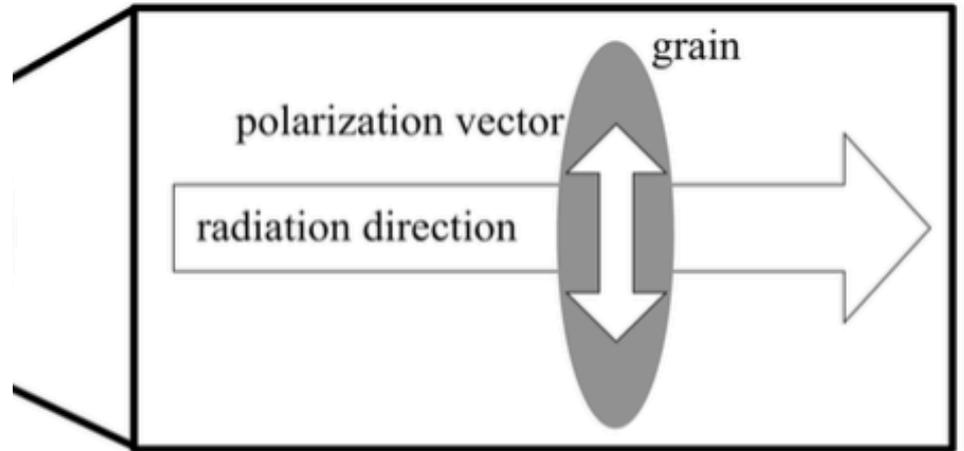


ent

tion direction



1%

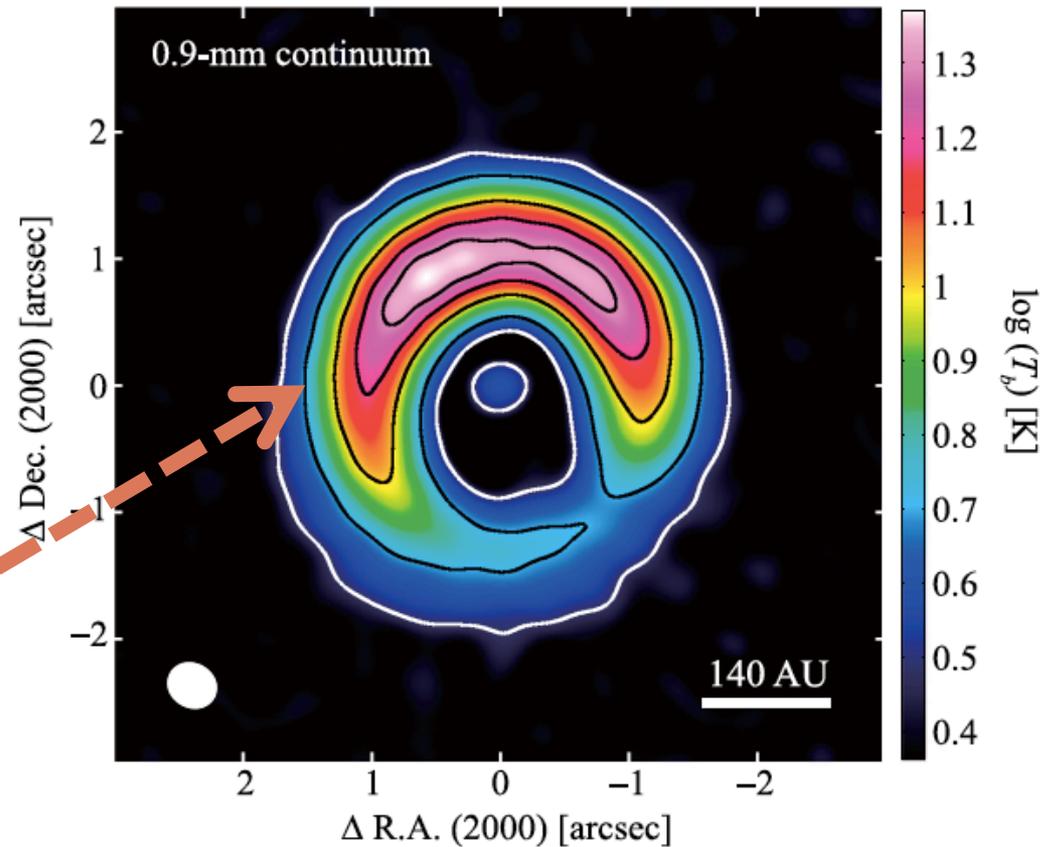


Protoplanetary disk HD 142527



- Herbig Fe star
- Pre Main Sequence
- 2.2 Msun (with 0.1 Msun binary at 15 au)
- $d \sim 156$ pc

dust accumulation or gravitationally unstable ?

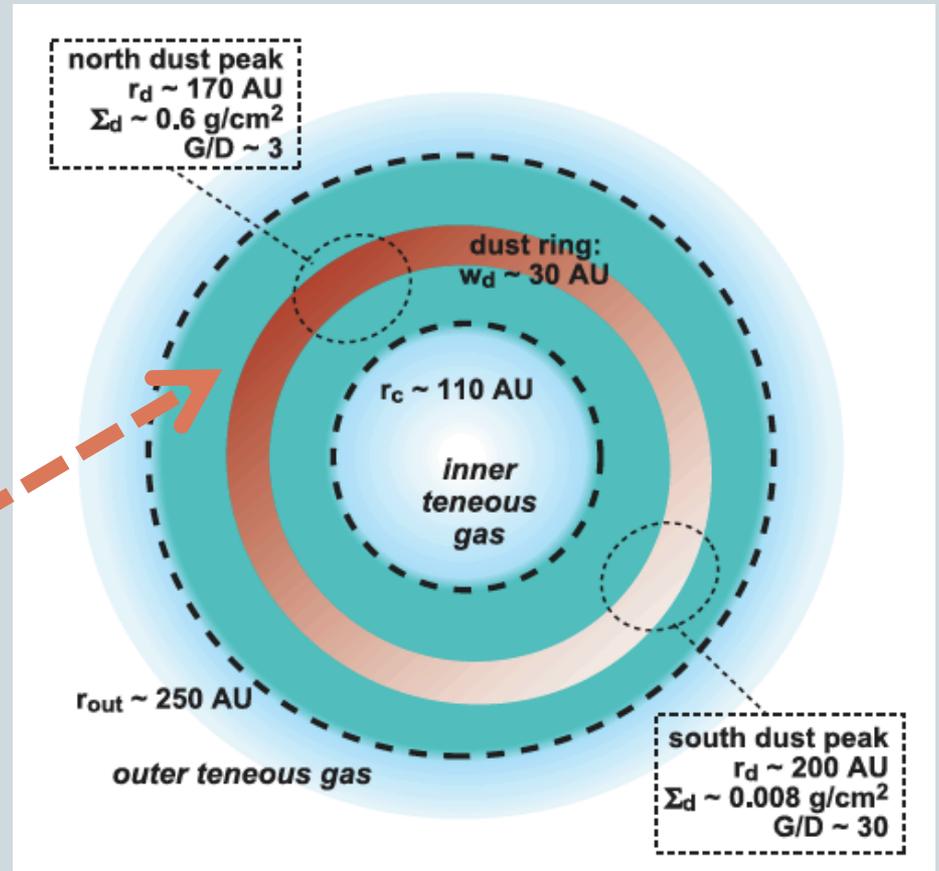


Protoplanetary disk HD 142527



- Herbig Fe star
- Pre Main Sequence
- 2.2 Msun (with 0.1 Msun binary at 15 au)
- $d \sim 156$ pc

dust accumulation by the pressure gas bump (Muto+15, Boehler+17)

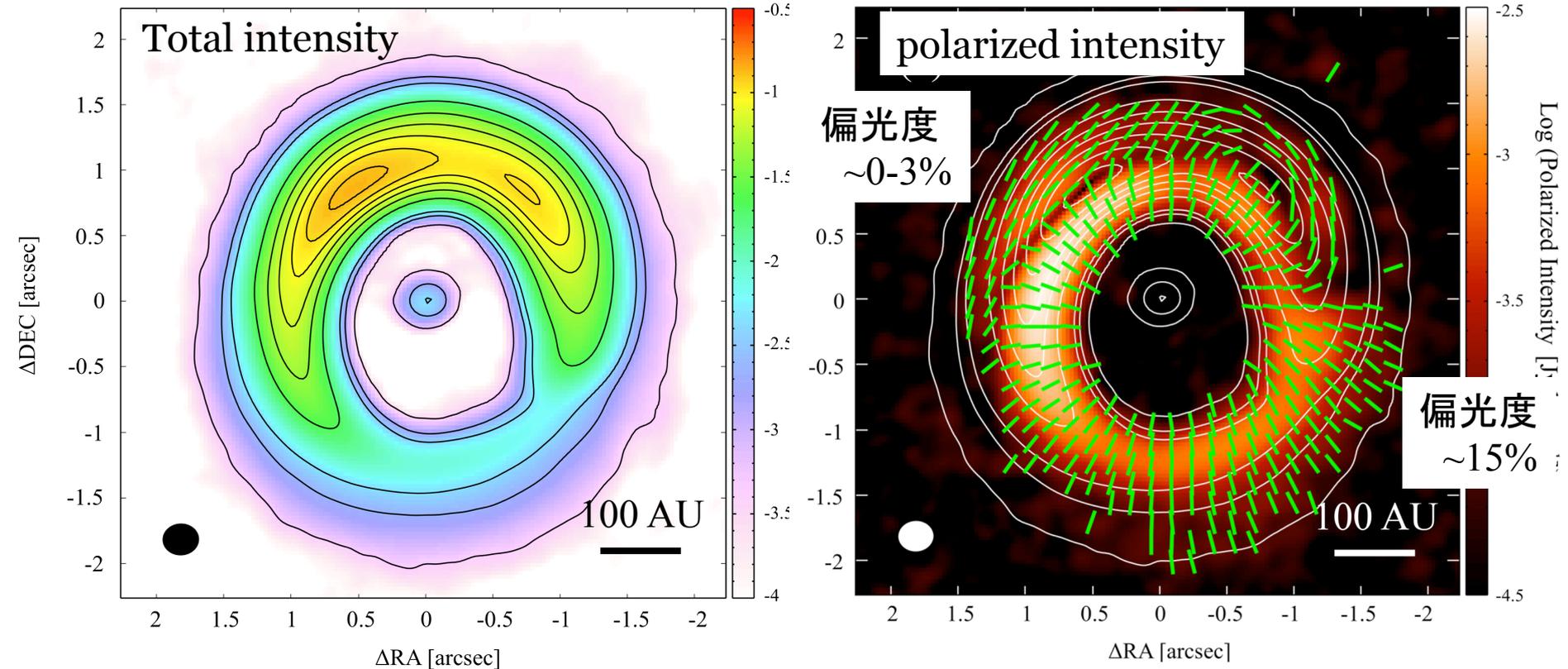


Muto et al. 2015

Polarization observation of HD 142527



- 円盤の偏光メカニズムを調べるため、ALMAによる高分解能、高感度の観測 ($\sim 0.25''$, 40 au)

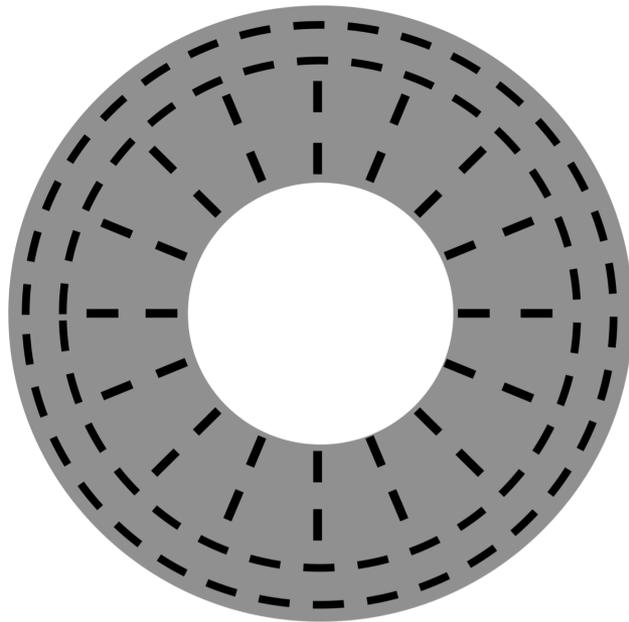


possible polarization in HD 142527



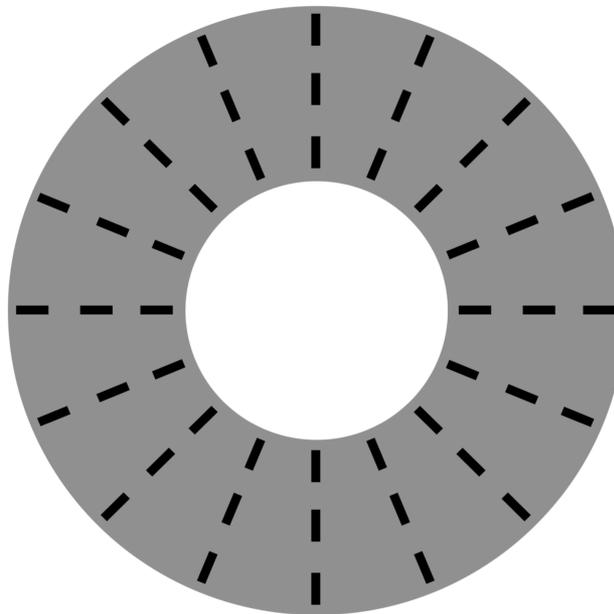
各偏光メカニズムで予想されるHD 142527の偏光ベクトルの様子

(a) self-scattering



Kataoka+16

(b) toroidal magnetic field



Cho & Lazarian 07

(c) radiative alignment

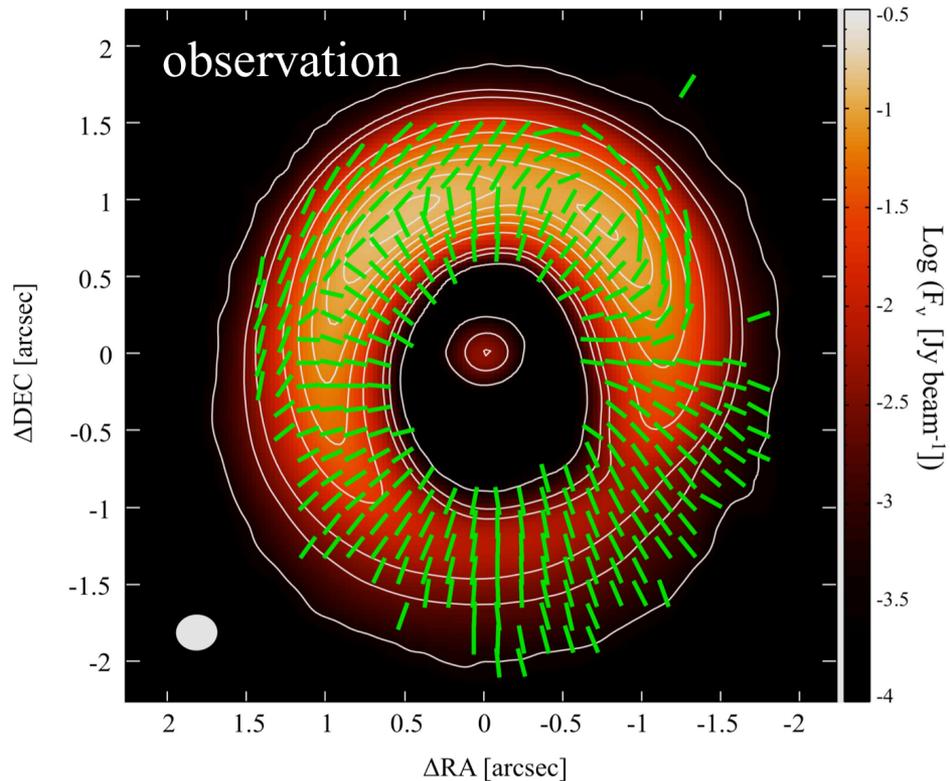
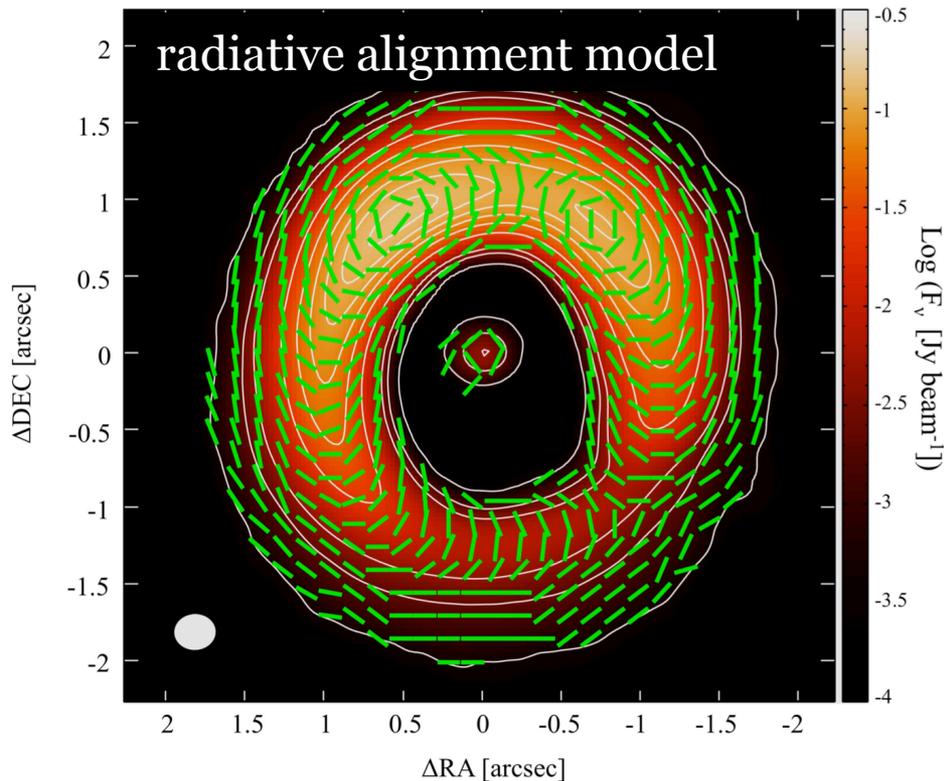


(Tazaki+17)

Model of radiative grain alignment



0.87 mmのイメージを輻射場として、各ピクセルにおける輻射場の方向を計算、輻射場によるダスト整列と偏光ベクトルを予想

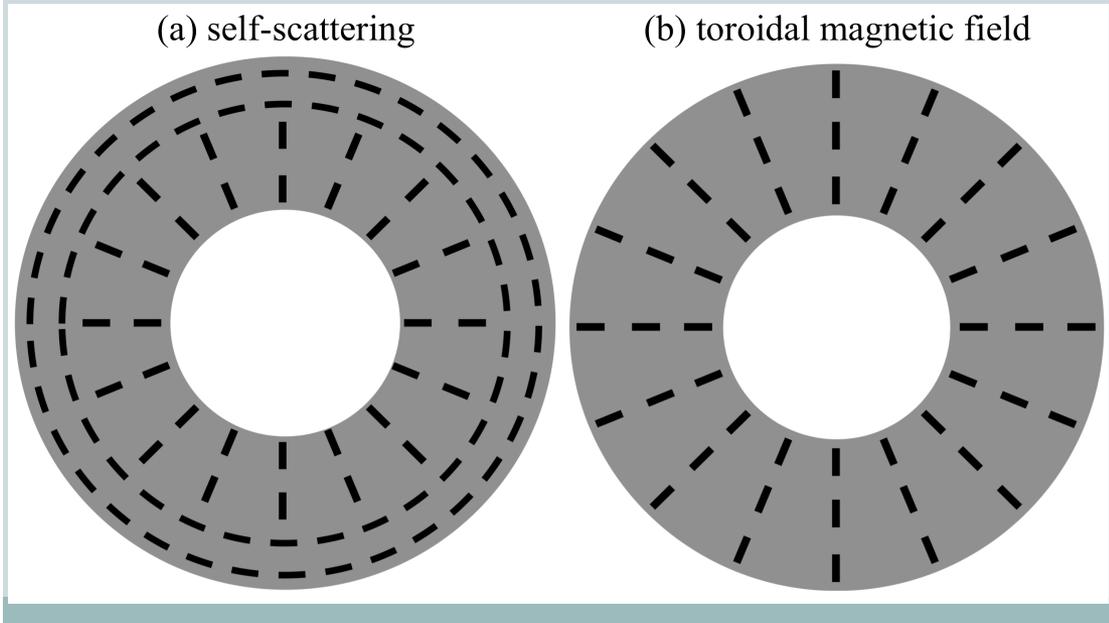
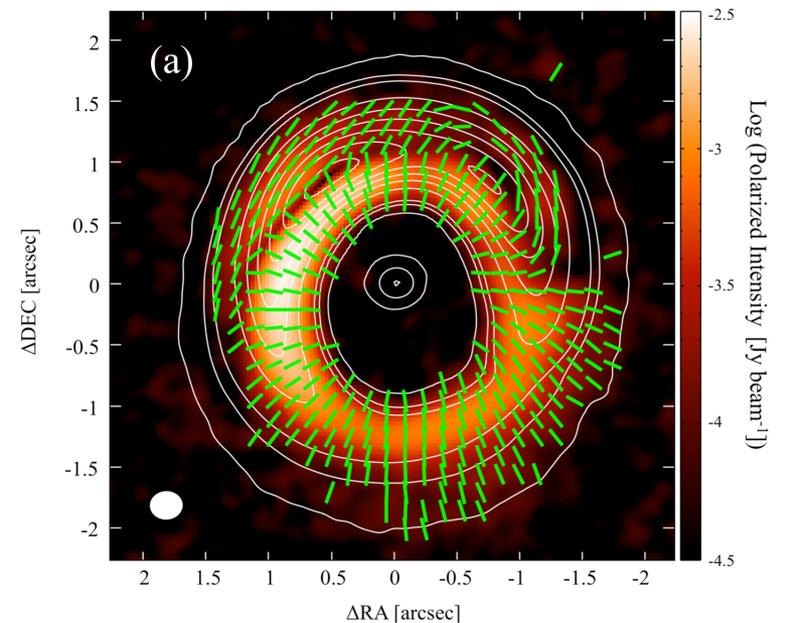


Polarization of HD 142527

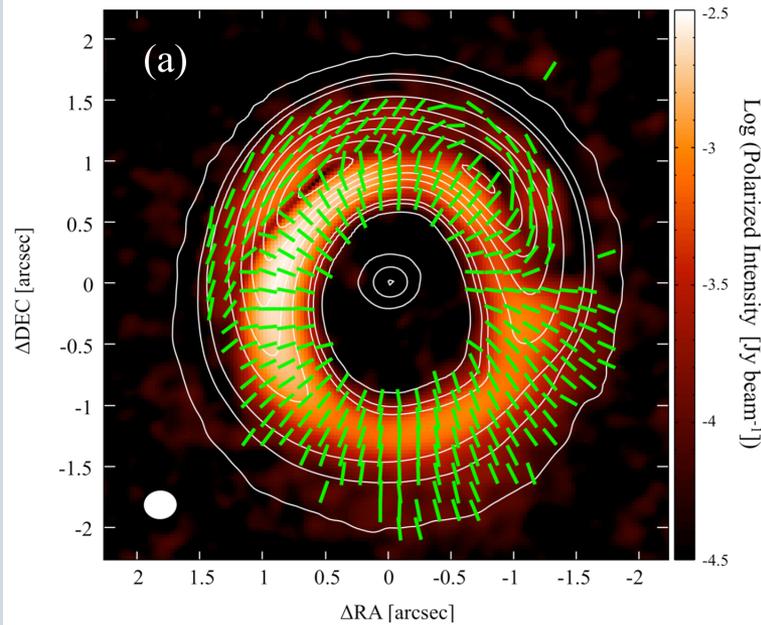


Table 1. Possible mechanisms of polarization

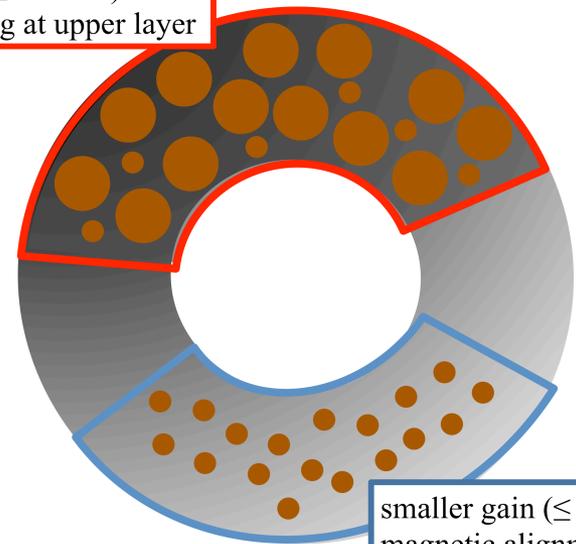
Polarization	Northern region	Southern region
Self-scattering	✓	✗
Grain alignment with magnetic field	✗	✓
Grain alignment with radiation gradient	✗	✗



Possible polarization of HD 142527



larger gain ($\geq 150 \mu\text{m}$)
self-scattering at upper layer



smaller gain ($\leq 100 \mu\text{m}$)
magnetic alignment

- 北側での偏光はダストの自己散乱によるものと考えられる。この場合、ダストのサイズは $\sim 150 \mu\text{m}$
- 北側は 0.87 mm では光学的に厚いため、円盤の上層部の偏光を見ている可能性があり、円盤の中央ではより大きなダストが存在している
- 南側では小さなダスト($< 100 \mu\text{m}$)が分布し磁場に整列する

Conclusion



- 原始惑星系円盤ではダストがトラップされて大きなダストが形成されることが示唆され、偏光観測でサイズを見積もれる
- 小さなダストが分布する領域では円盤でも磁場を観測できる
- 非軸対象な円盤では異なるダストサイズ分布を持つことを観測から明らかにした

原始惑星系円盤での偏光はダストのサイズに依存する

*多波長偏光観測をすることで、散乱やダスト整列であることを確かめられる。