Thüringer
Landes-
Sternwarte

Investigation of periodic maser outbursts in young stars with SOFIA

Presented by Christian Andreas, Stuttgart, 2024 April 24

Heritage of SOFIA – Scientific Highlights and Future Perspectives

Outline

I. Role of masers in Young Stellar Objects (YSOs)

II. G107.298+5.638

III. G37.554+0.201

IV. Origins of periodic masers

V. Summary & Outlook

Protostar within L1527 © APOD

Image courtesy slide 1: Webb Space Telescope

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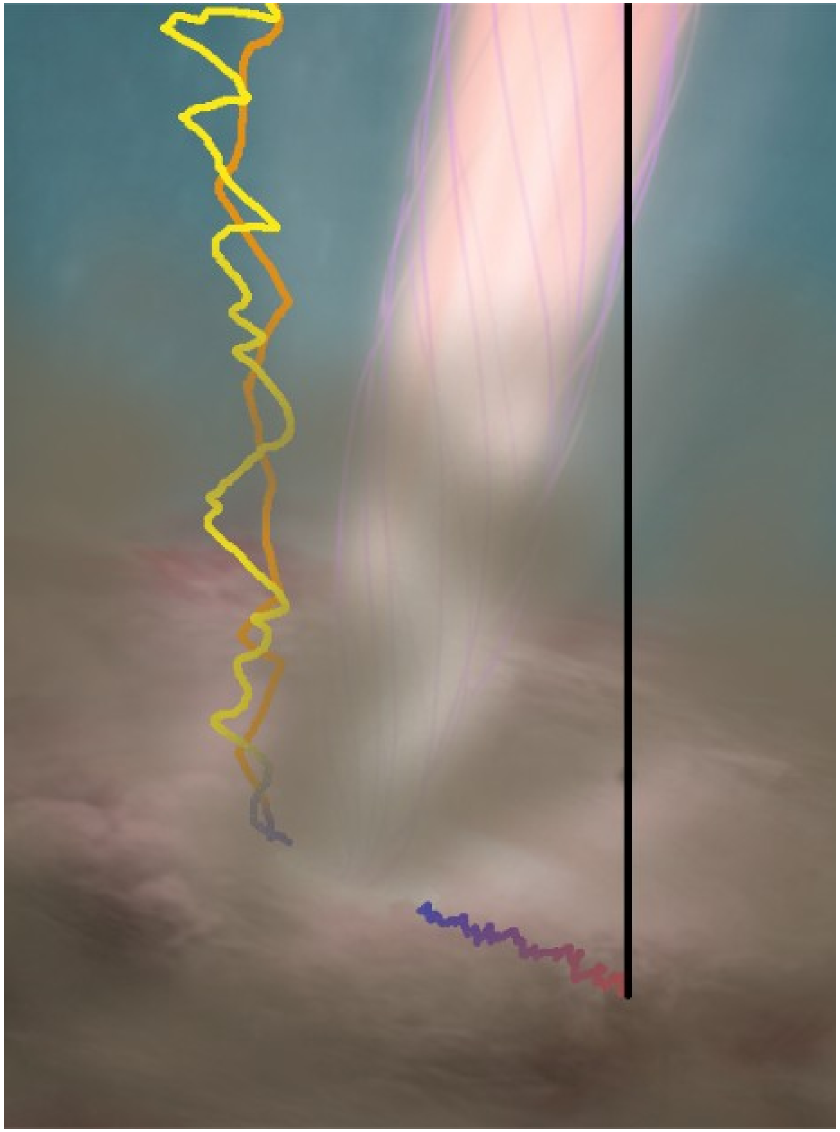
I. Masers in YSOs



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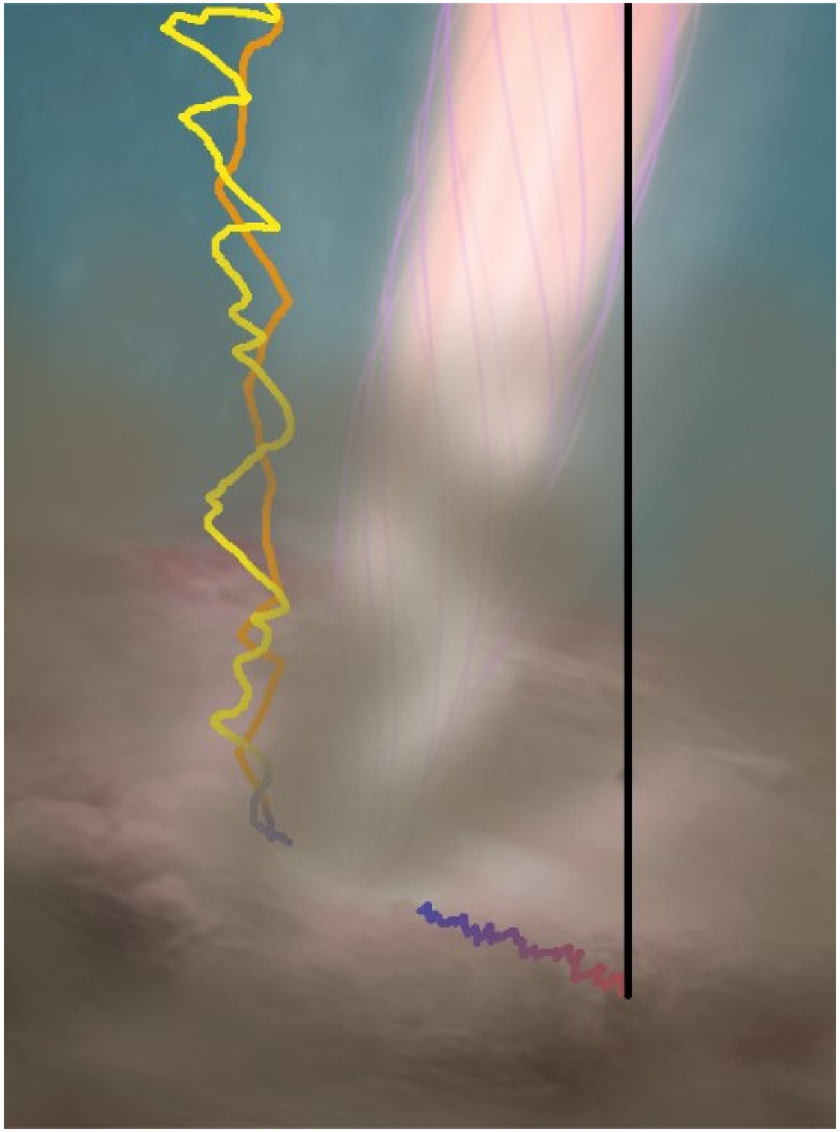

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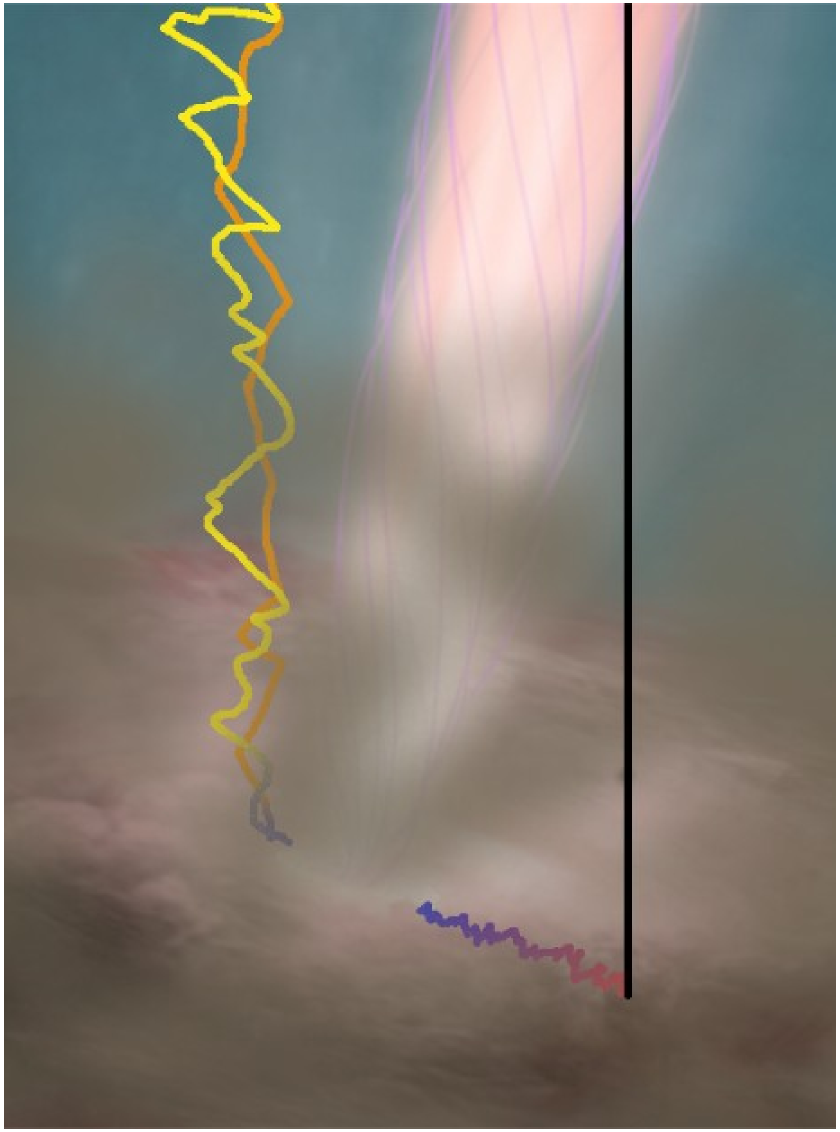

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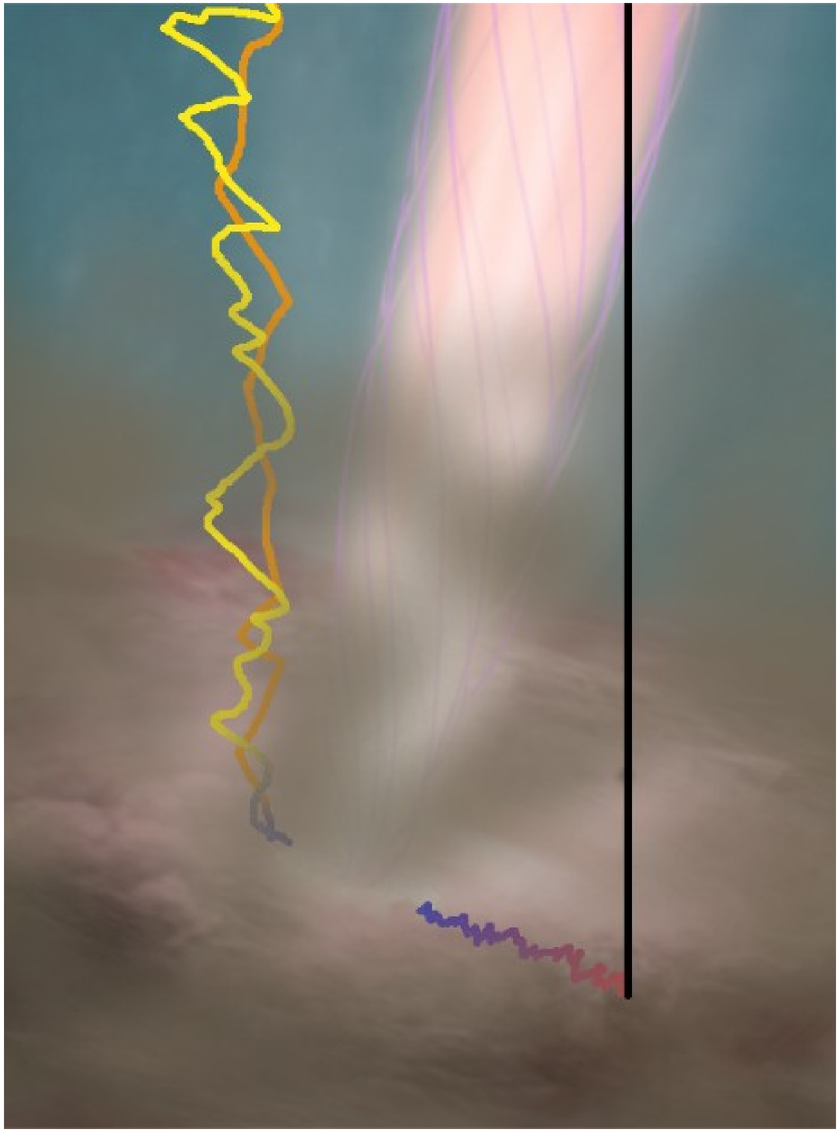

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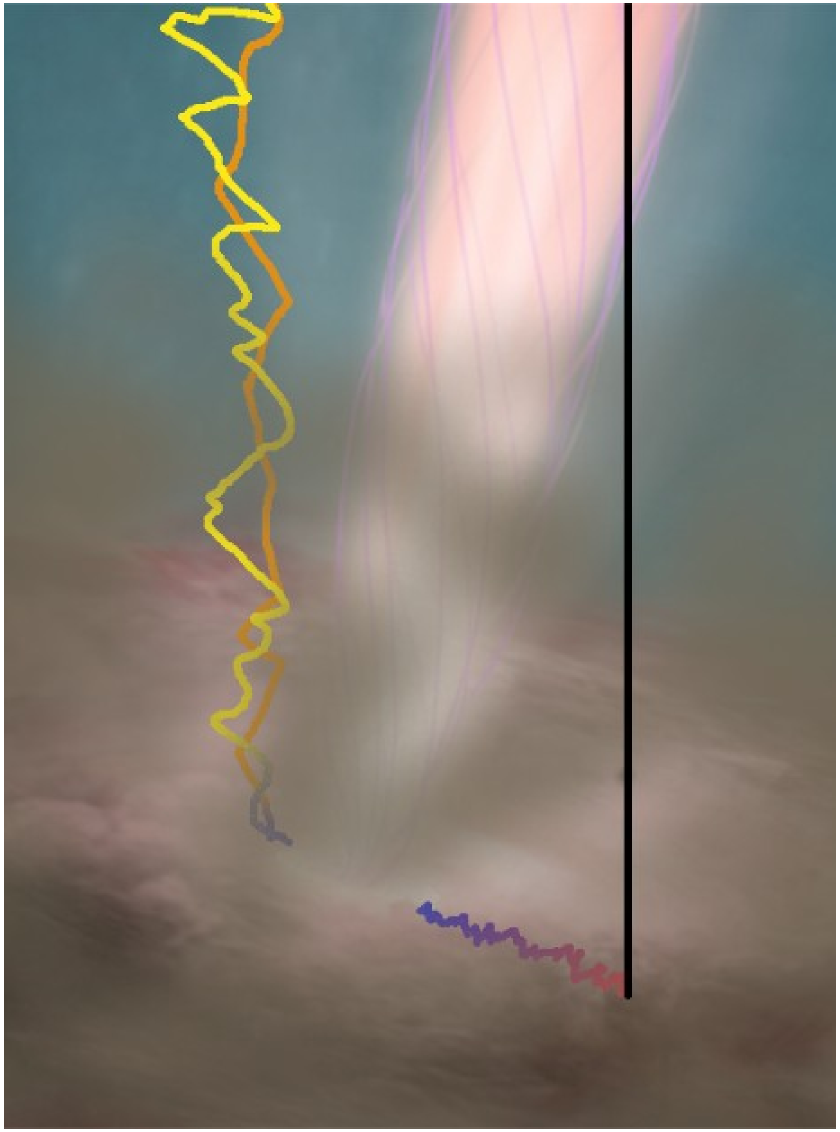
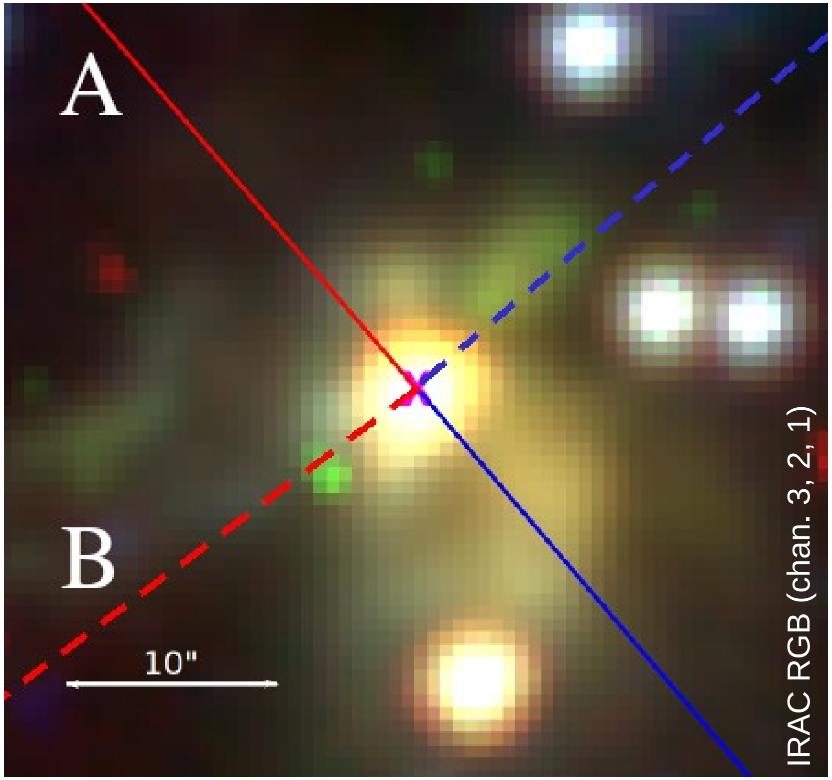
- **Periodic variability** (~ 20 - 1600 d) due to variations in the seed photon flux or the dust temperature



II. G107.298+5.638

Characteristics

Distance	764 ± 27 pc
Stellar mass	~ 2 … 7 $M_\odot$
Luminosity	~ 340 … 800 $L_\odot$
6.7 GHz maser period	34.4 ± 0.7 d



Stecklum + 2017, Sánchez-Monge + 2010, Palau + 2013

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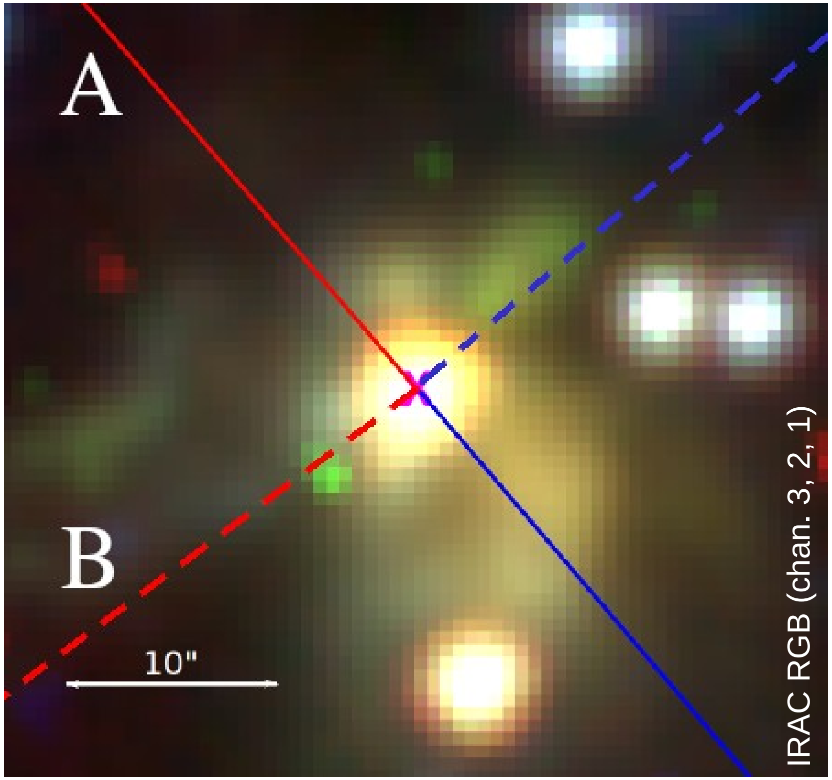

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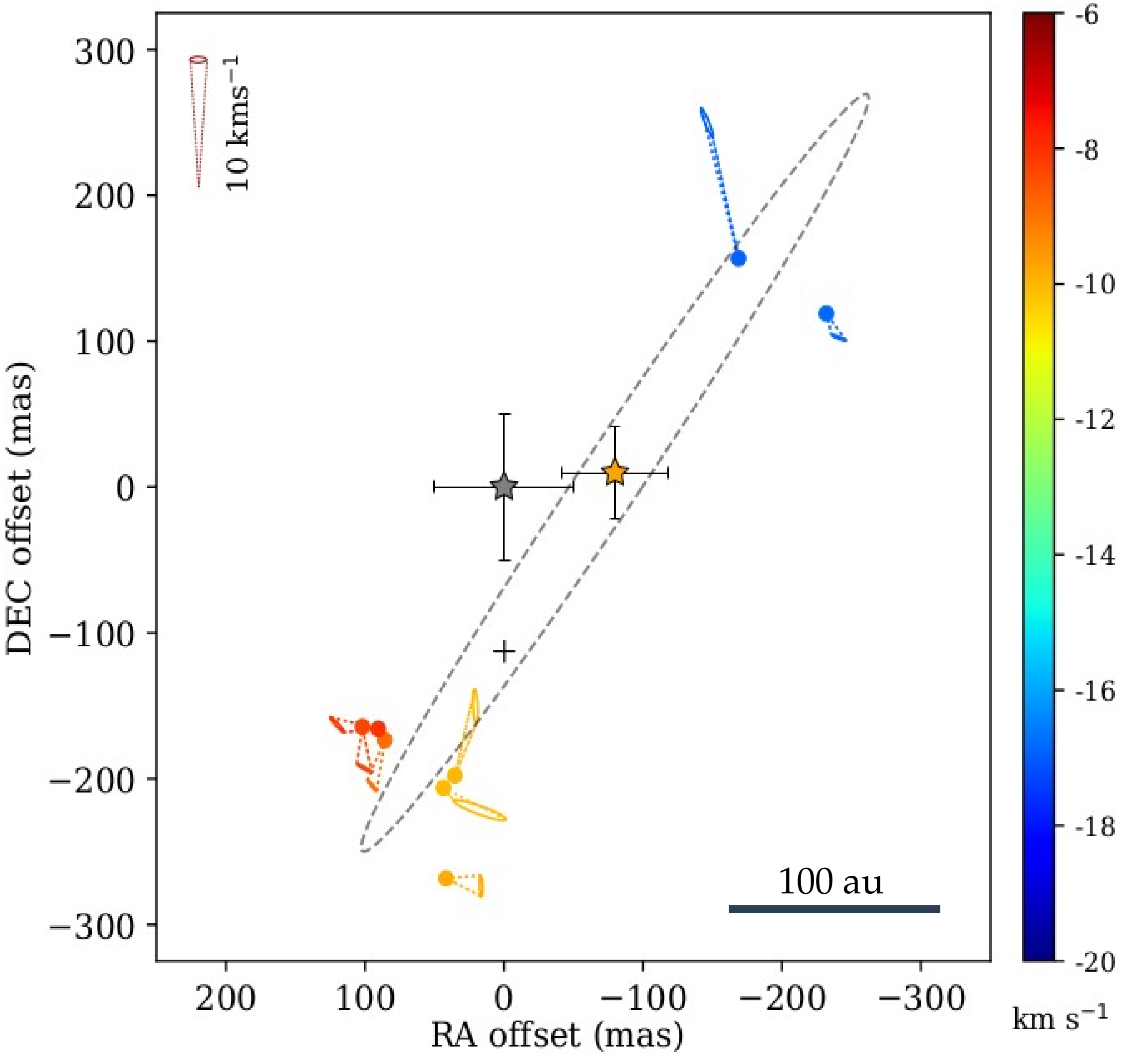
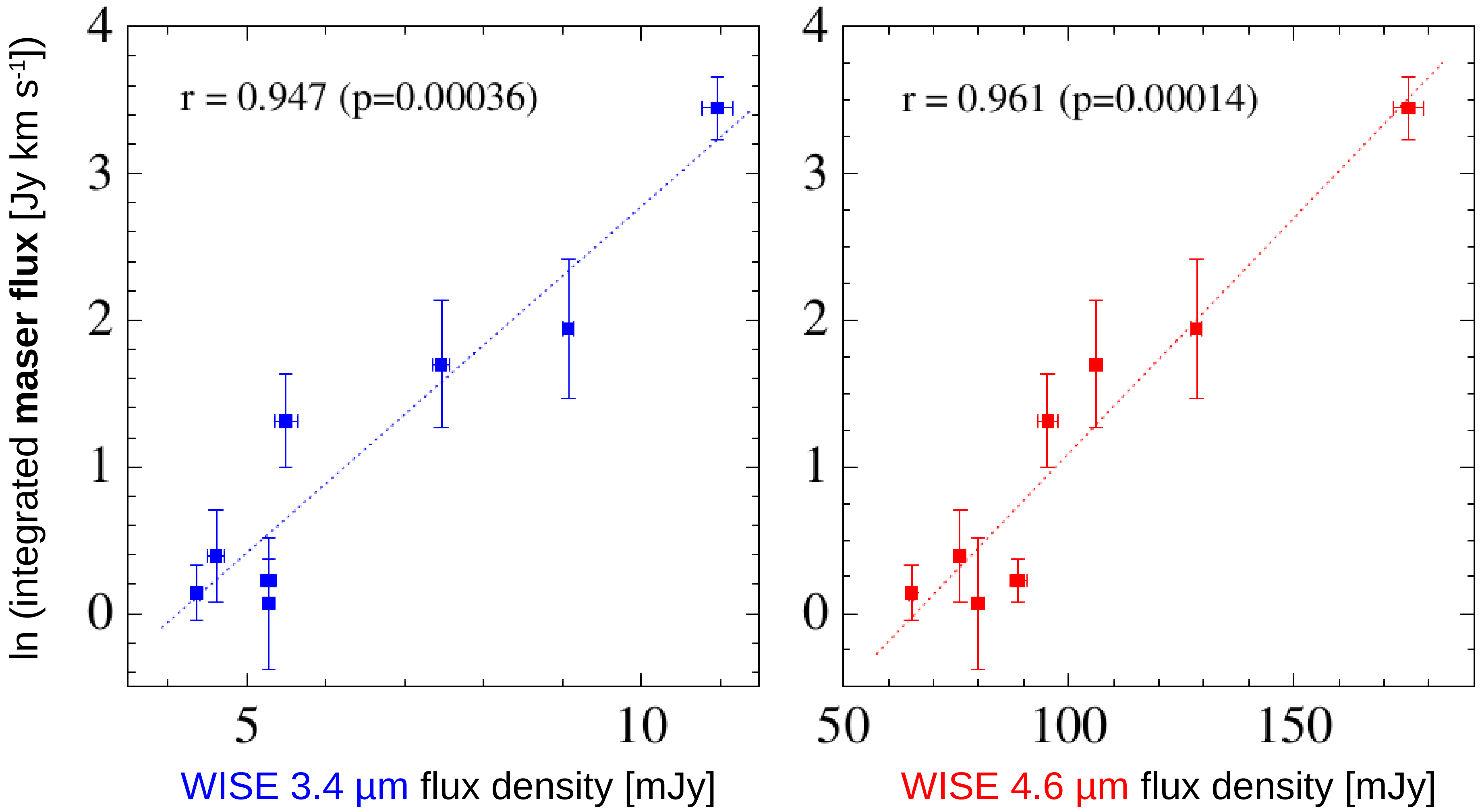


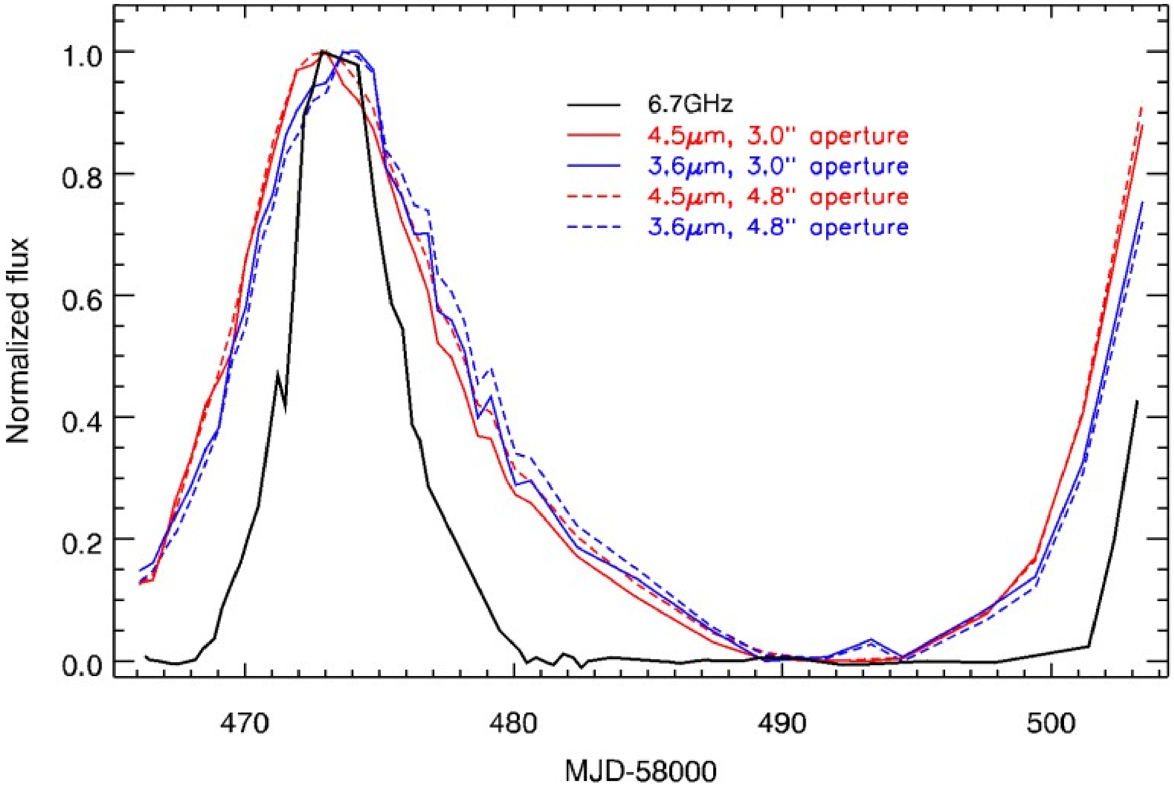
II. Correlation of radio & MIR flux

Olech + 2020



II. Timelines of recent observations

Stecklum + 2020 (Spitzer Legacy Meeting)



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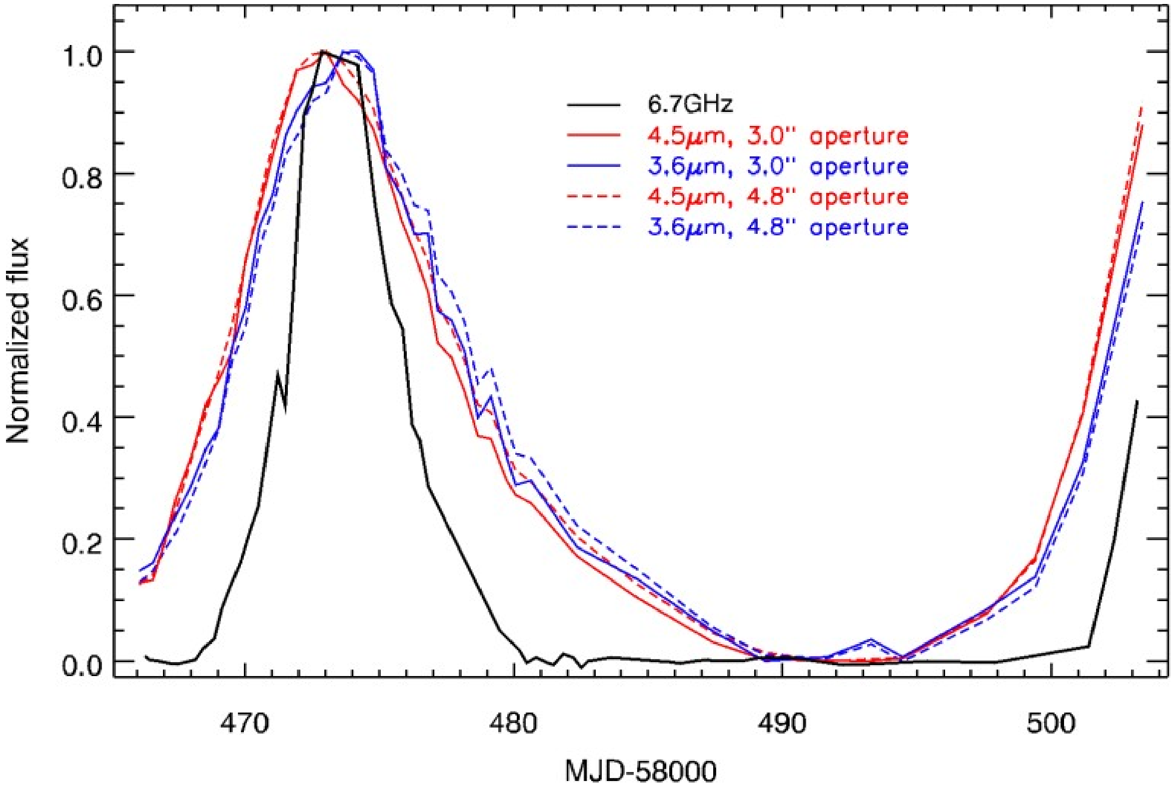
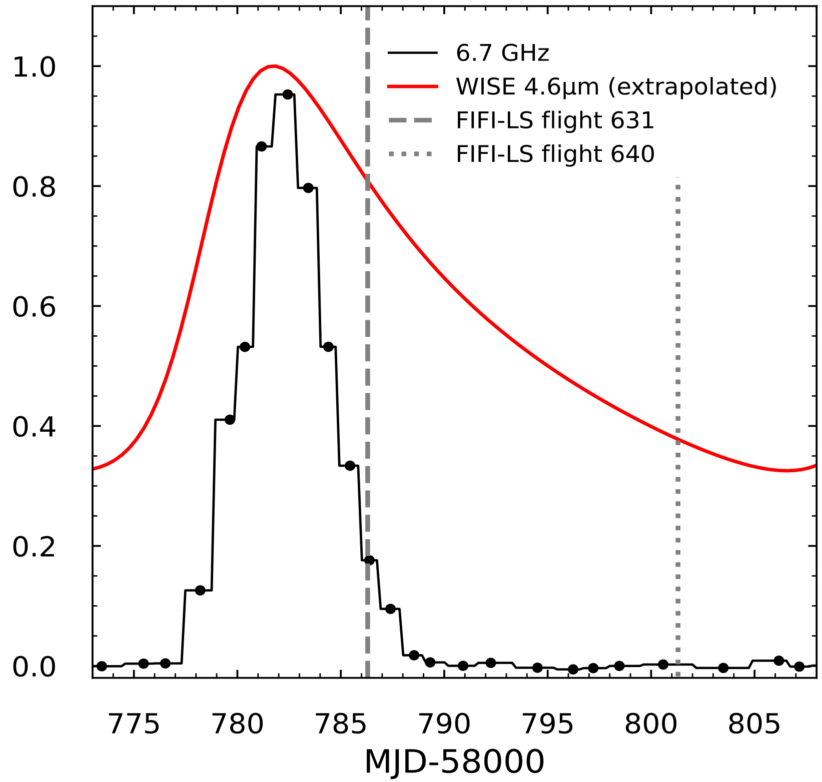
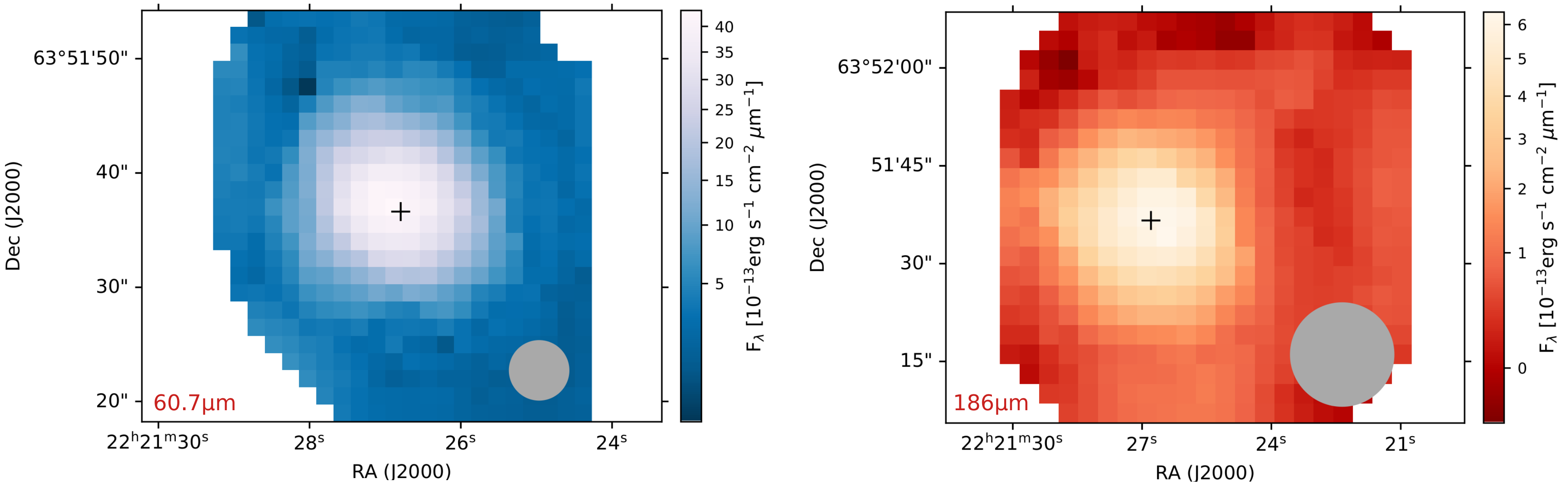




II. FIFI-LS OBSERVATIONS OF G107



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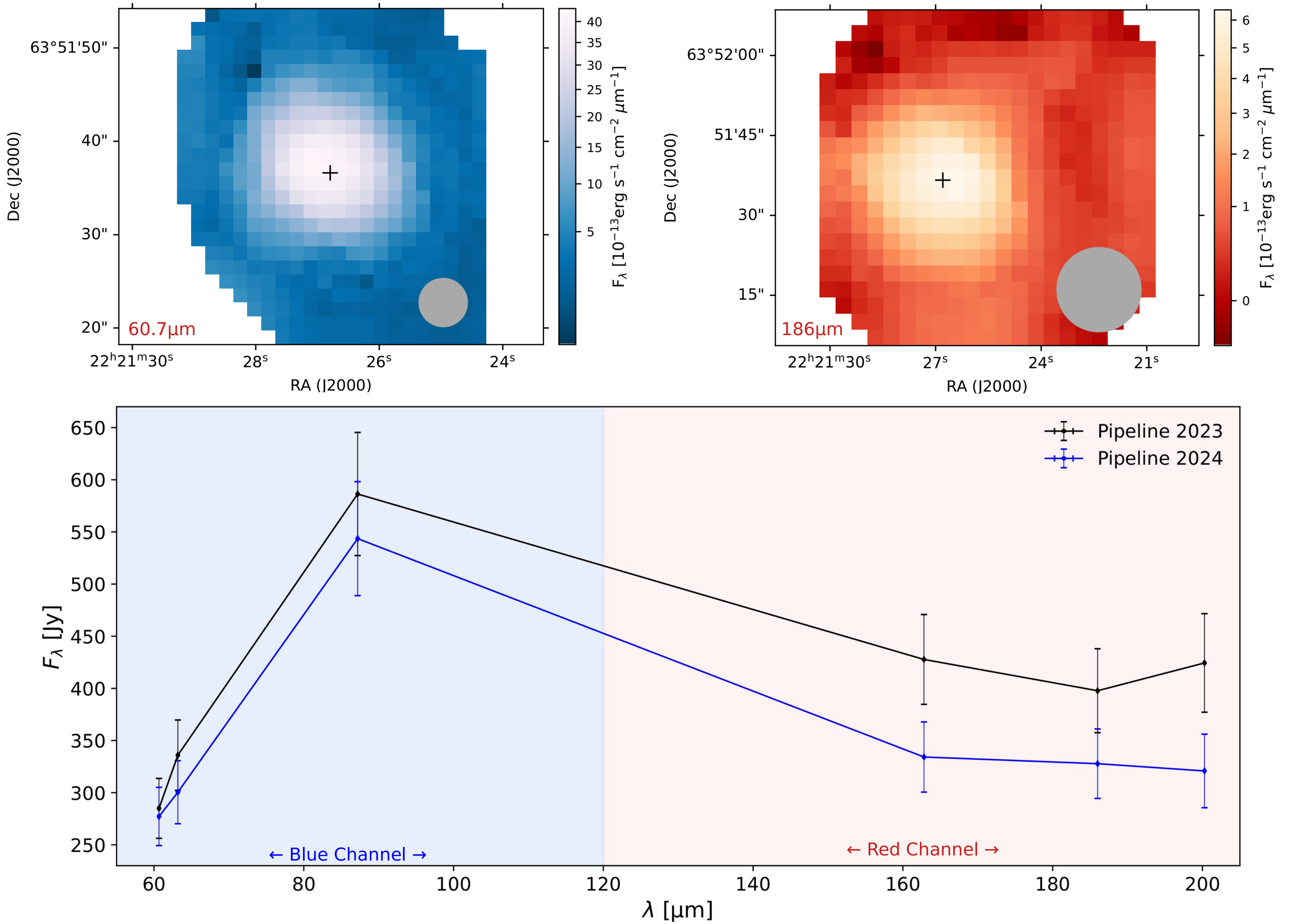

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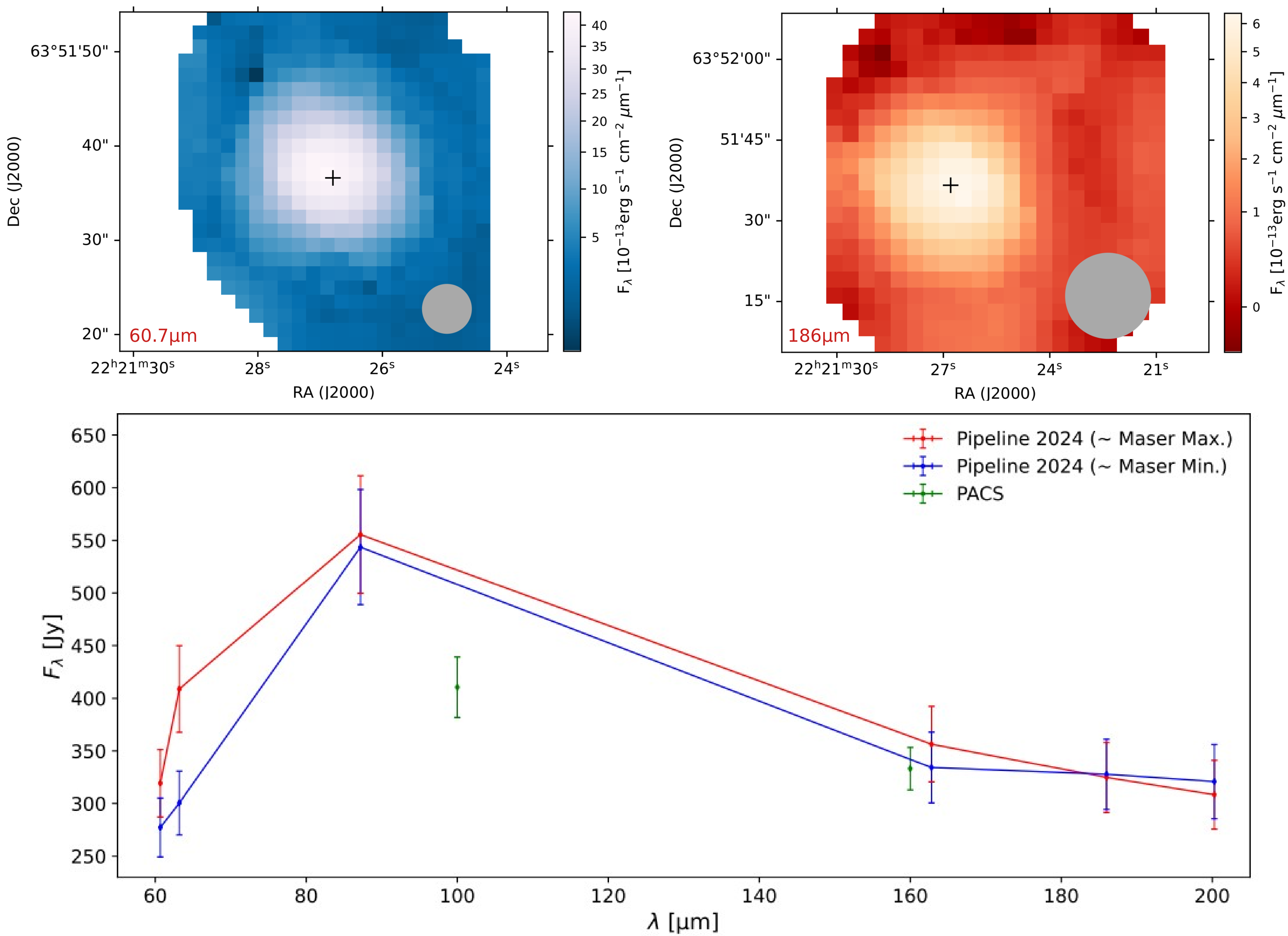
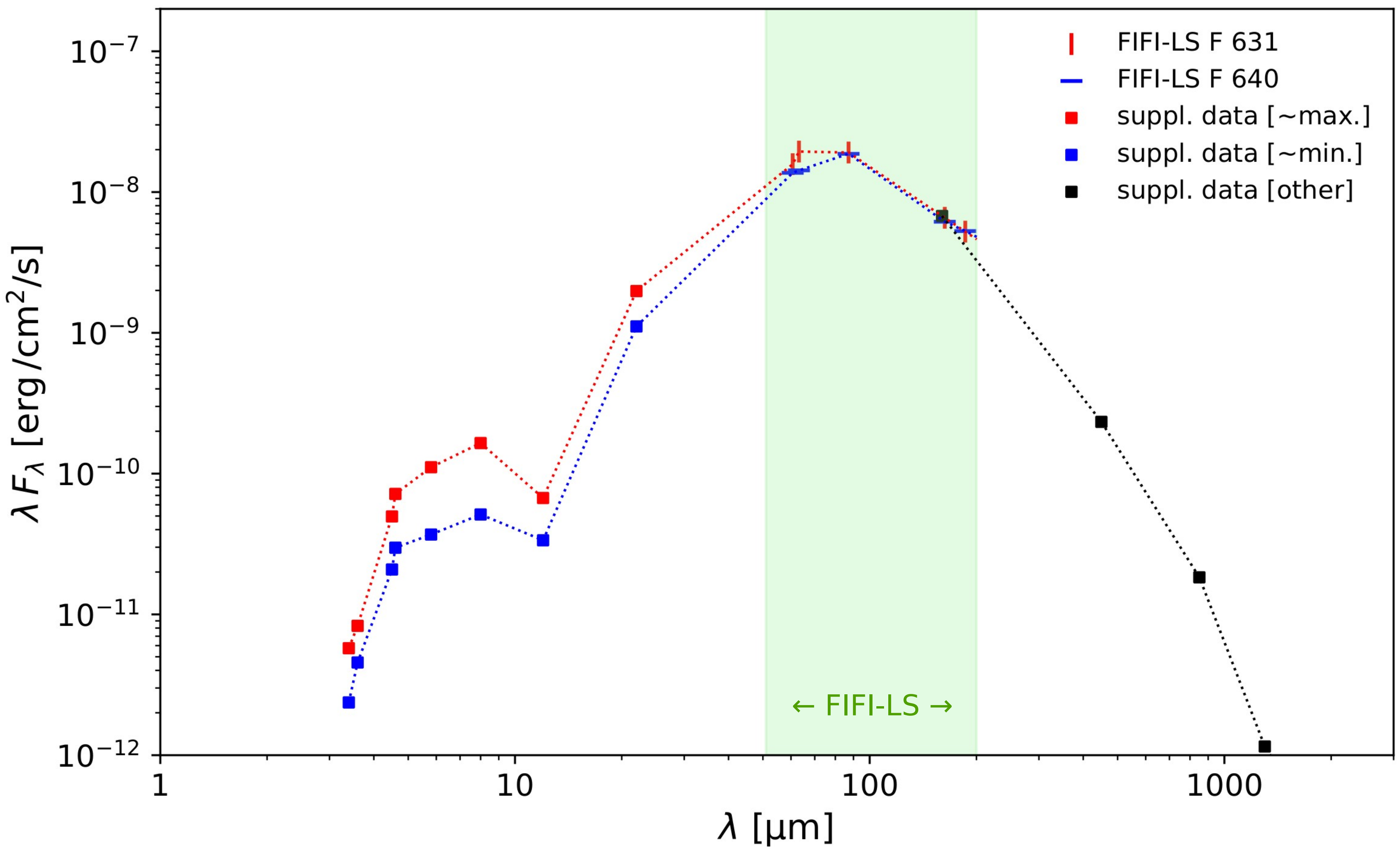
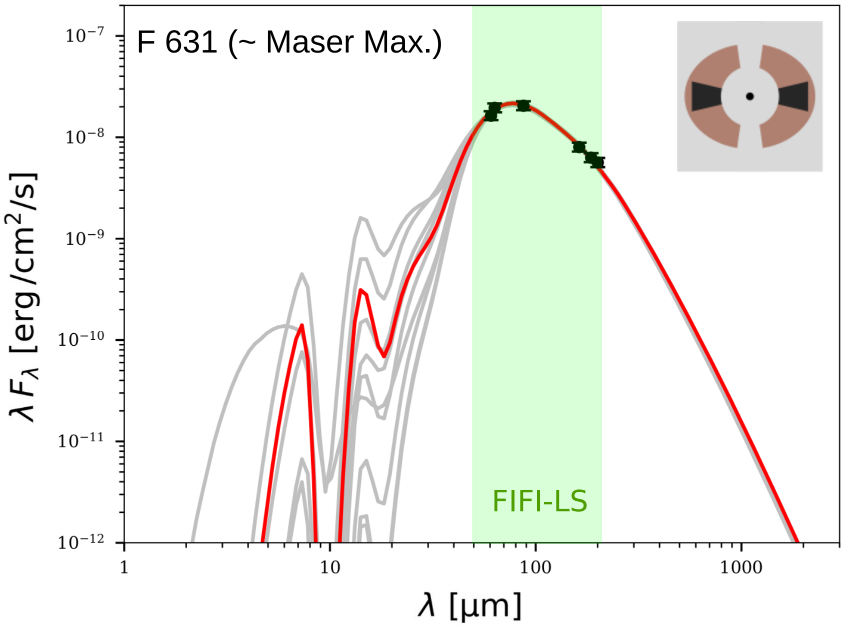
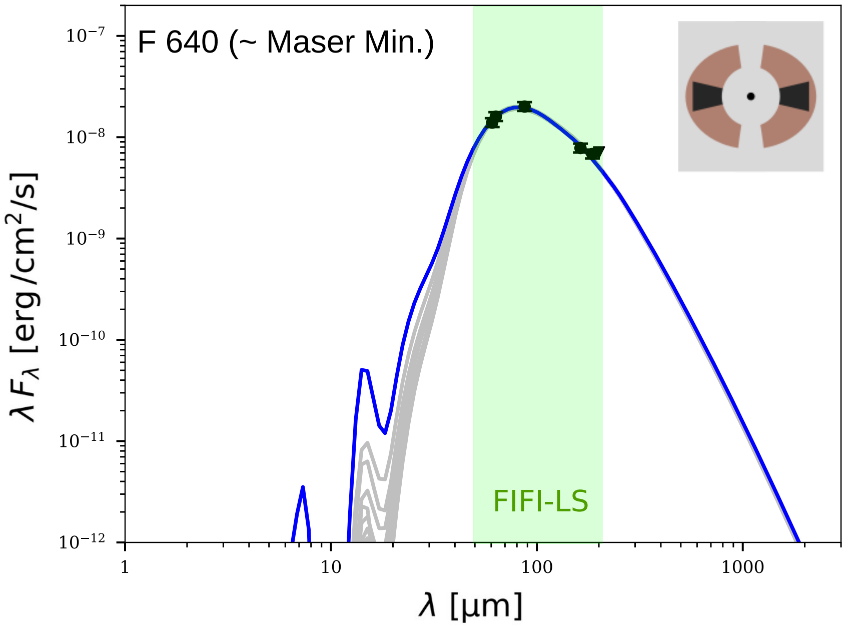


II. Inclusion of archival data



II. Time-independant RT modelling *





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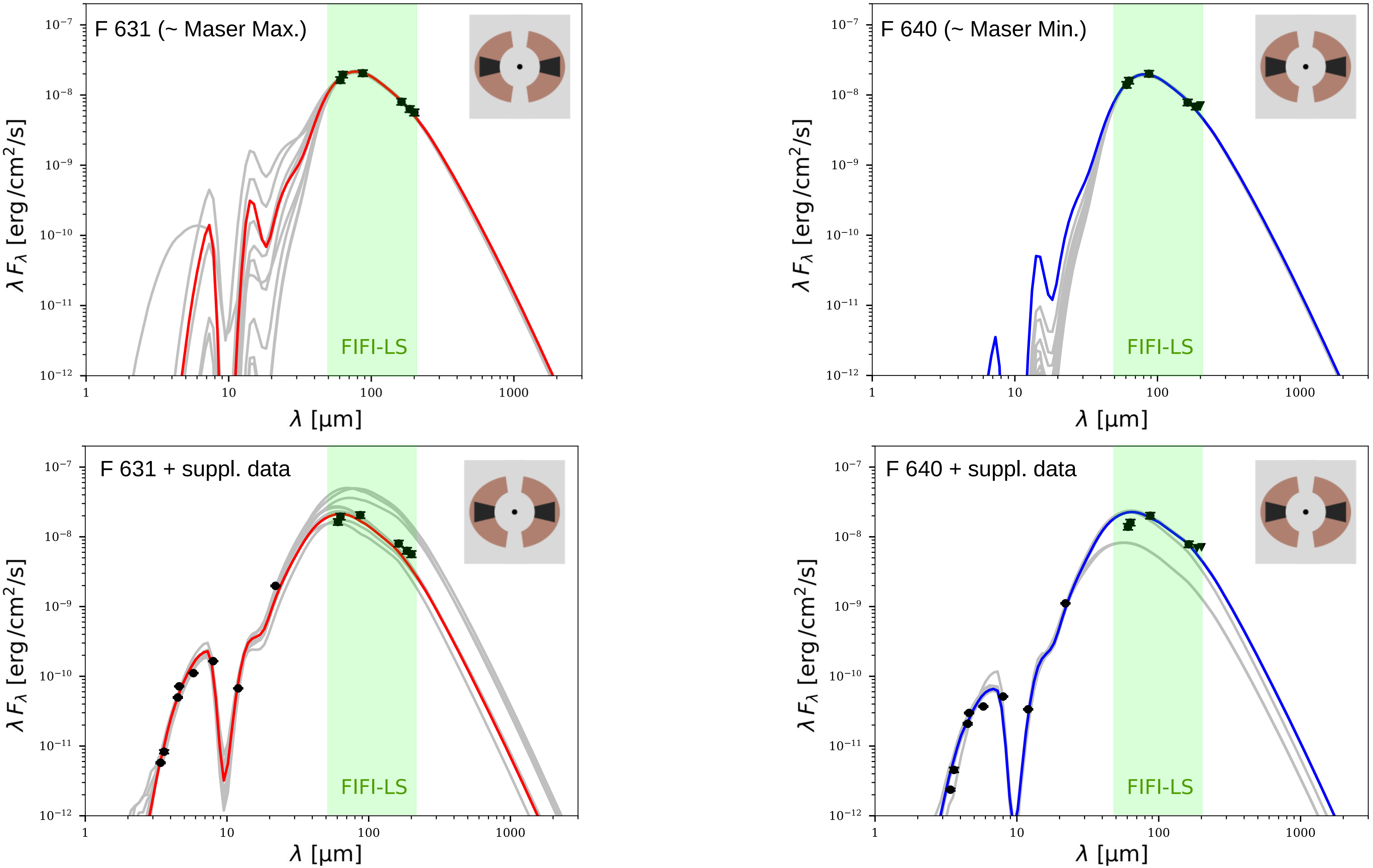

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II. Derived SED fit parameters

G 107

Data	**λ_{range} [μm]**	**L (λ_{range}) [$L_{\odot}$]**	**E_{acc} (λ_{range}) [J]**	**M_{acc} (λ_{range}) [$M_{☾}$]**
a) FIFI-LS flight 631	60.7 ... 200.3	**326 ± 27**		
b) FIFI-LS flight 640	60.7 ... 200.3	**306 ± 23**		

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c) suppl. data + a)	3.4 ... 7000	**607 ± 203**	**≈ 4.4 x 10^{34}**	
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c) suppl. data + a)	3.4 ... 7000	**607 ± 203**	**≈ 4.4 x 10^{34}**	**≈ 0.32**
d) suppl. data + b)	3.4 ... 7000	**528 ± 174**		

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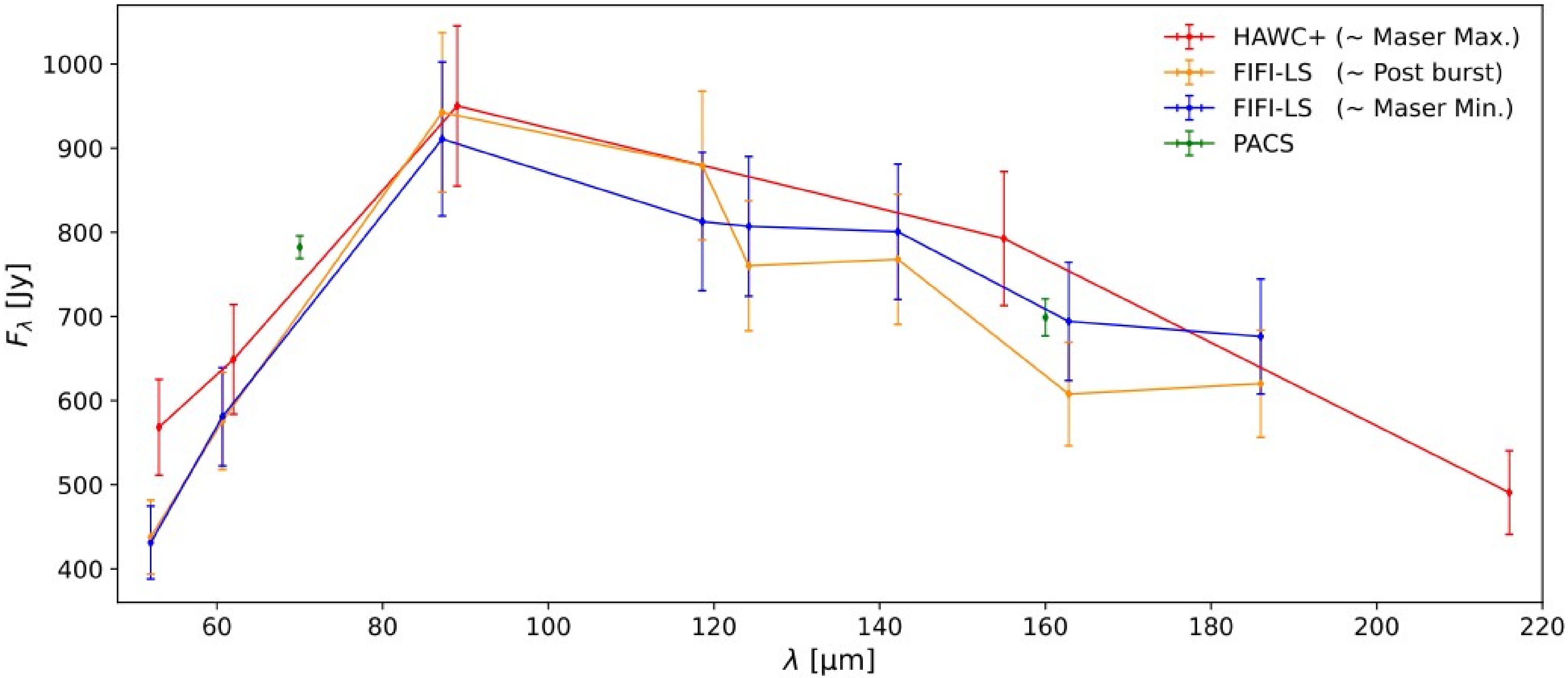

IV. Origins of periodic masers

- **Solitary systems:** Dust heating via
  - **Cyclic accretion instabilities** due to interactions between magnetosphere and disk

© STD, artist's impression

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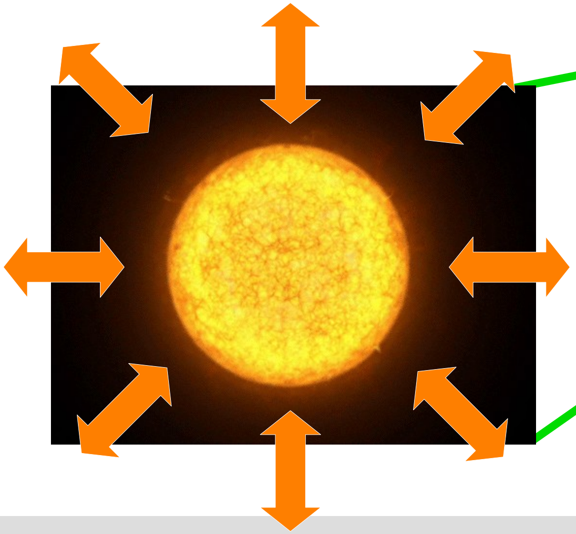
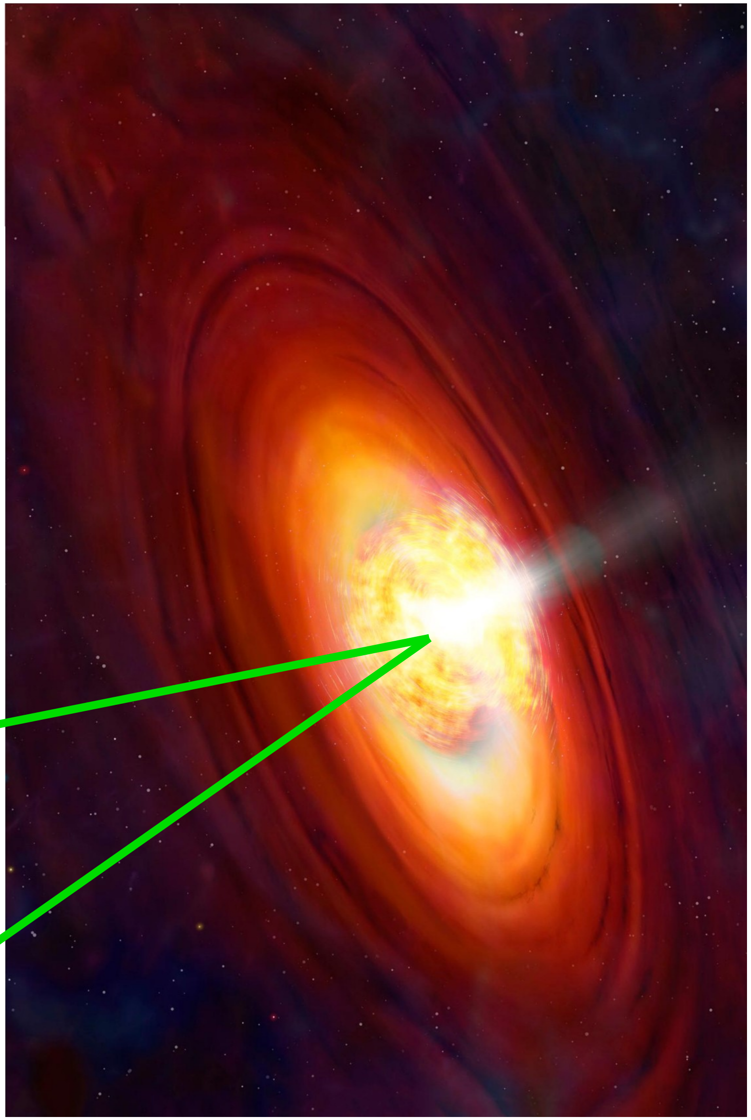
- **Cyclic accretion instabilities** due to interactions between magnetosphere and disk

- **Pulsations of massive protostars** and/or inner accretion disks





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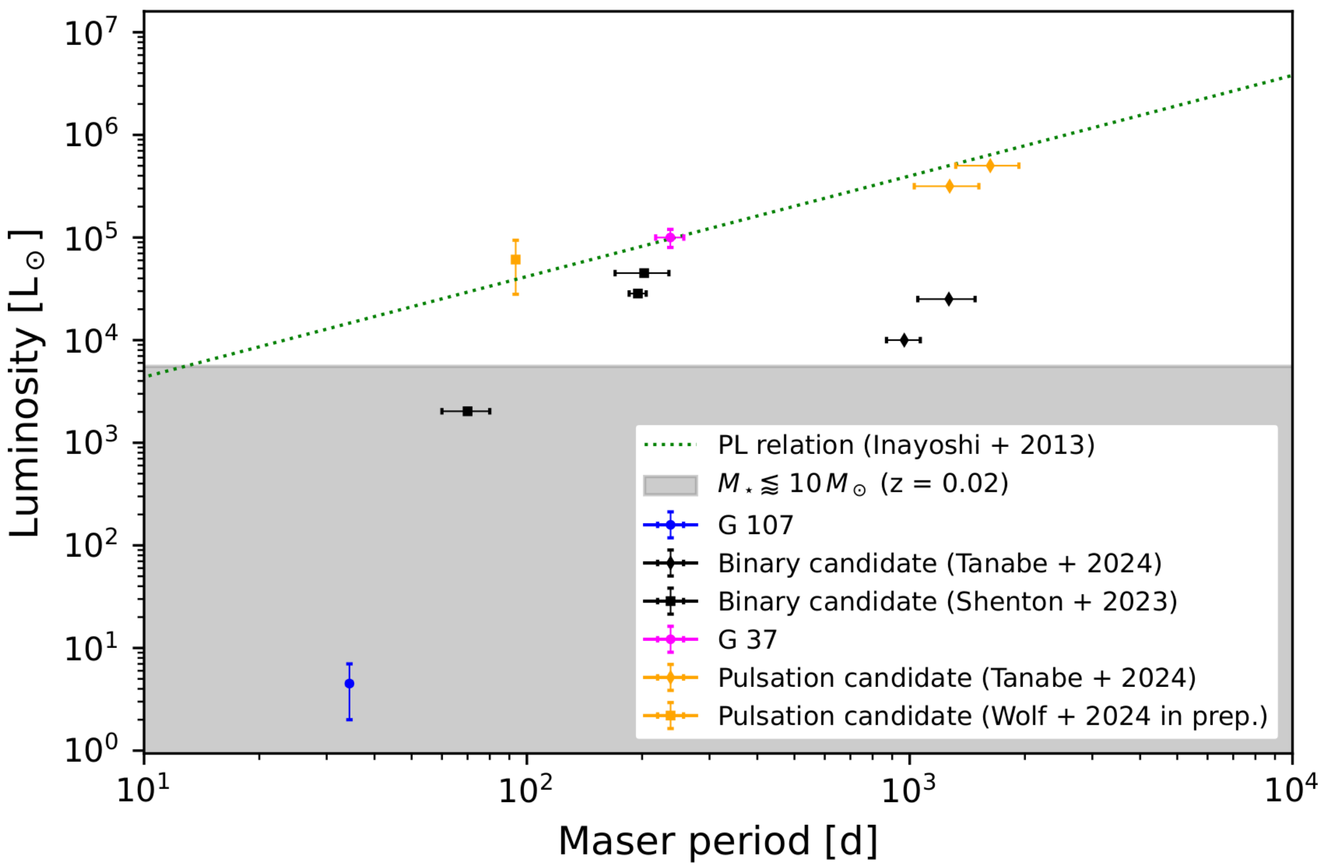
  - **Derived relation** between maser period and stellar luminosity (PL relation) **suitable in G 37,** but **not in G 107**



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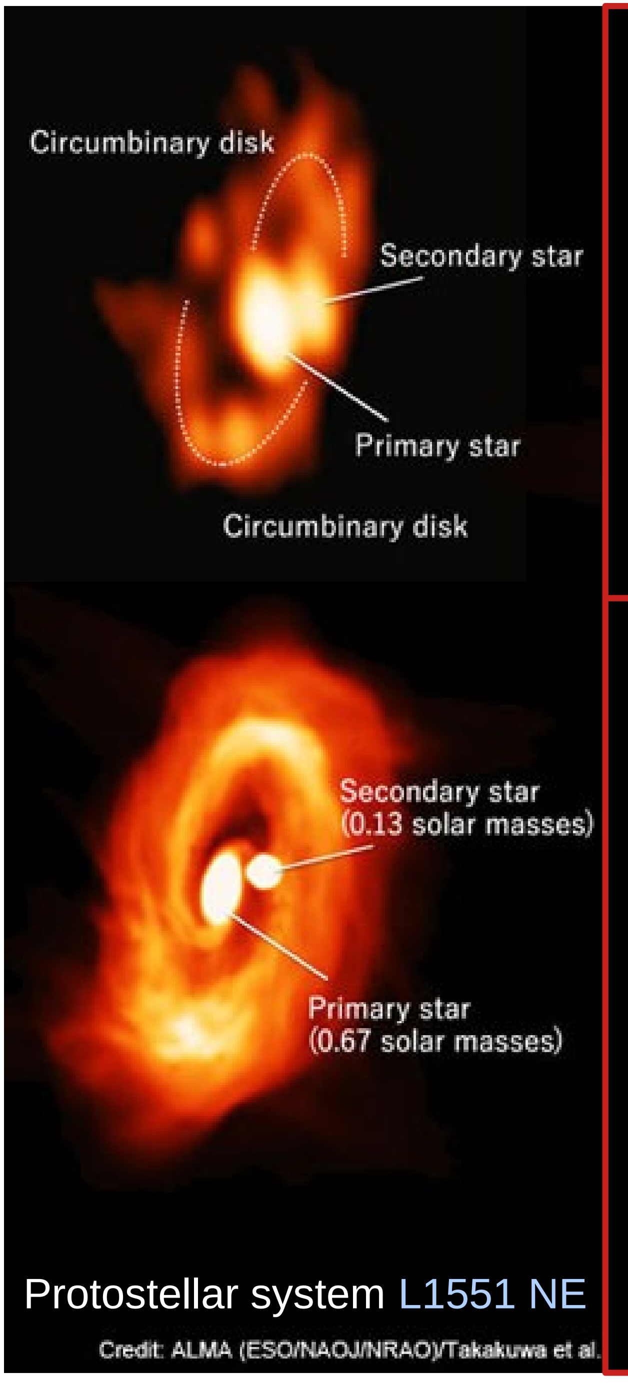

ALMA OBS.

NUM. SIMULATION

IV. Origins of periodic masers

- **Binary systems**
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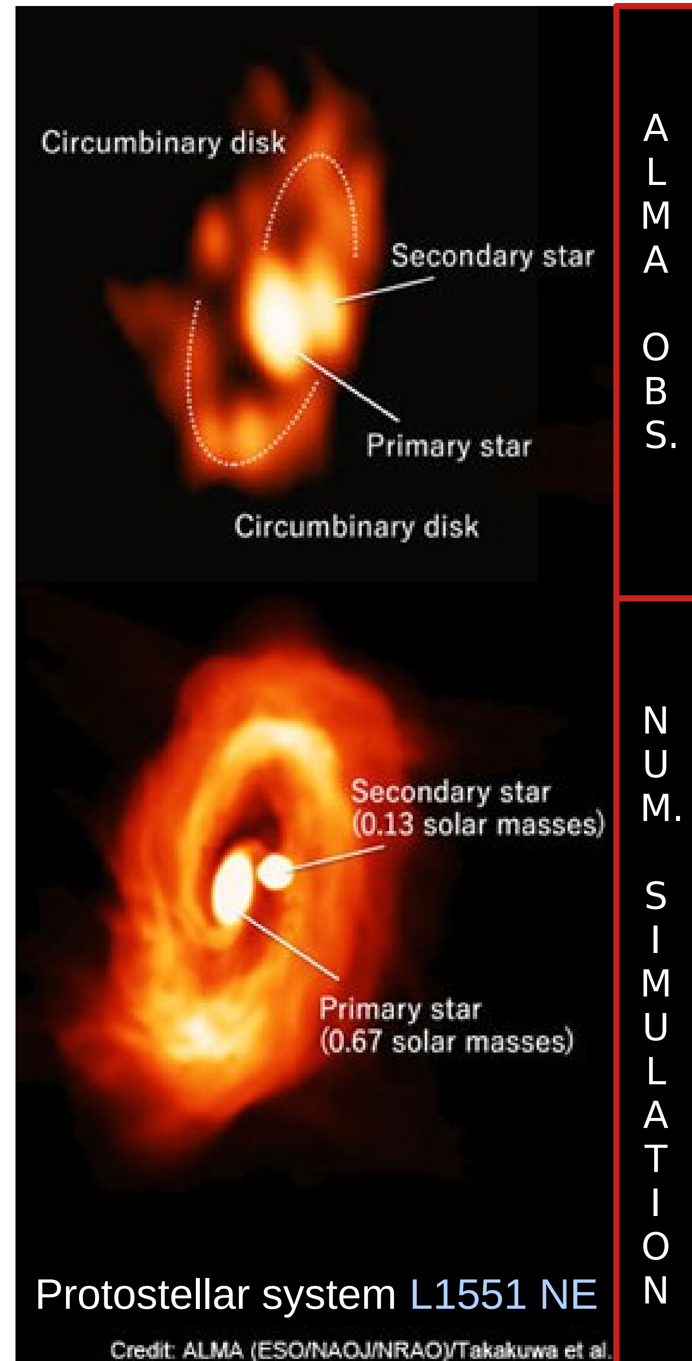
  - **Dust heating via** rotating **spiral shocks** in the gap of a circumbinary accretion disk **or pulsed accretion** from the disk



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