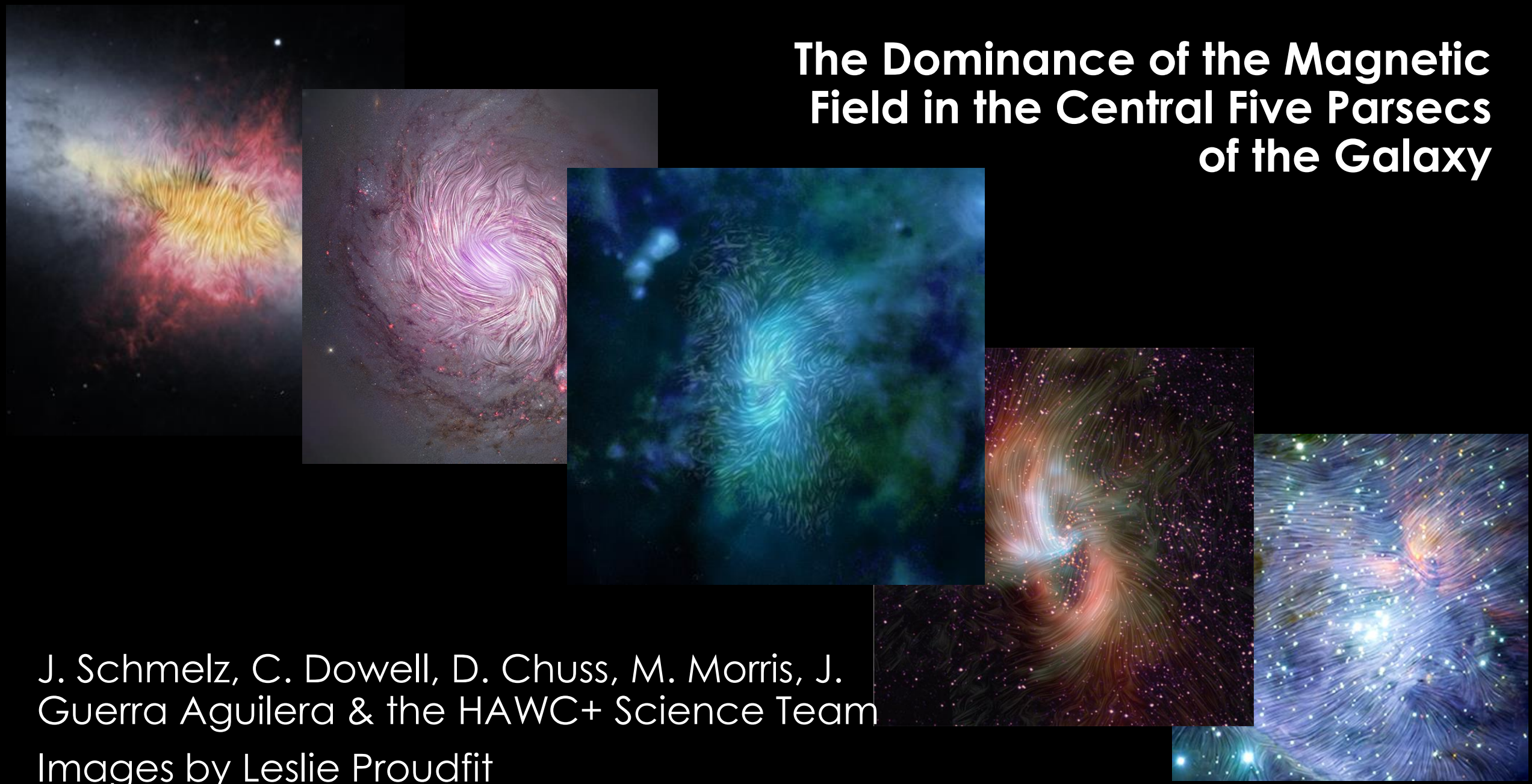
The Dominance of the Magnetic Field in the Central Five Parsecs of the Galaxy



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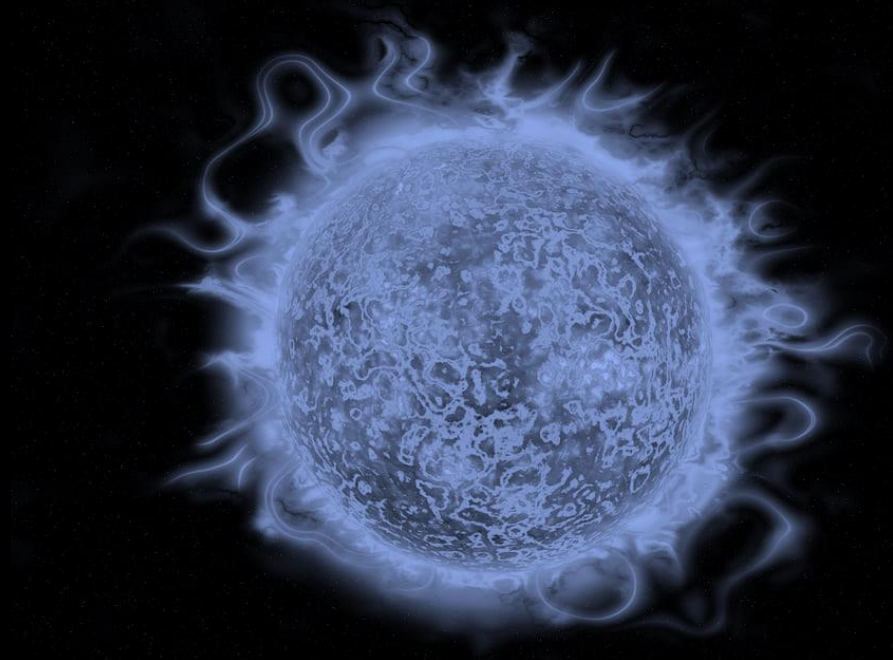
Images by Leslie Proudfit



Perspective

- Ask an Astronomer:
  - Is the magnetic field important in your research?
    No

- Hydrodynamics (HD)
  - the study of fluids in motion
  - Newtonian Mechanics

- Magneto-hydrodynamics (MHD)
  - the study of *electrically conducting* fluids in motion
  - Newtonian Mechanics plus Maxwell's Equations

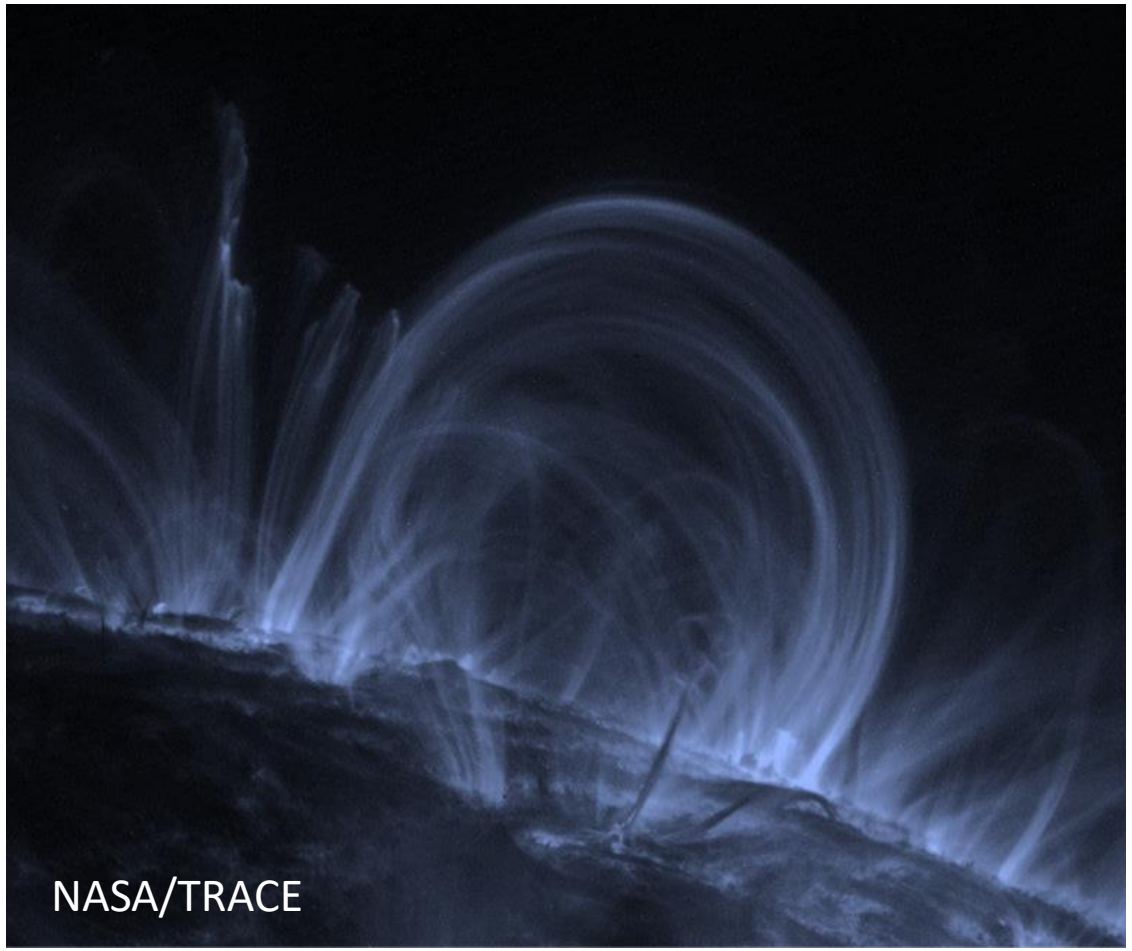
Perspective

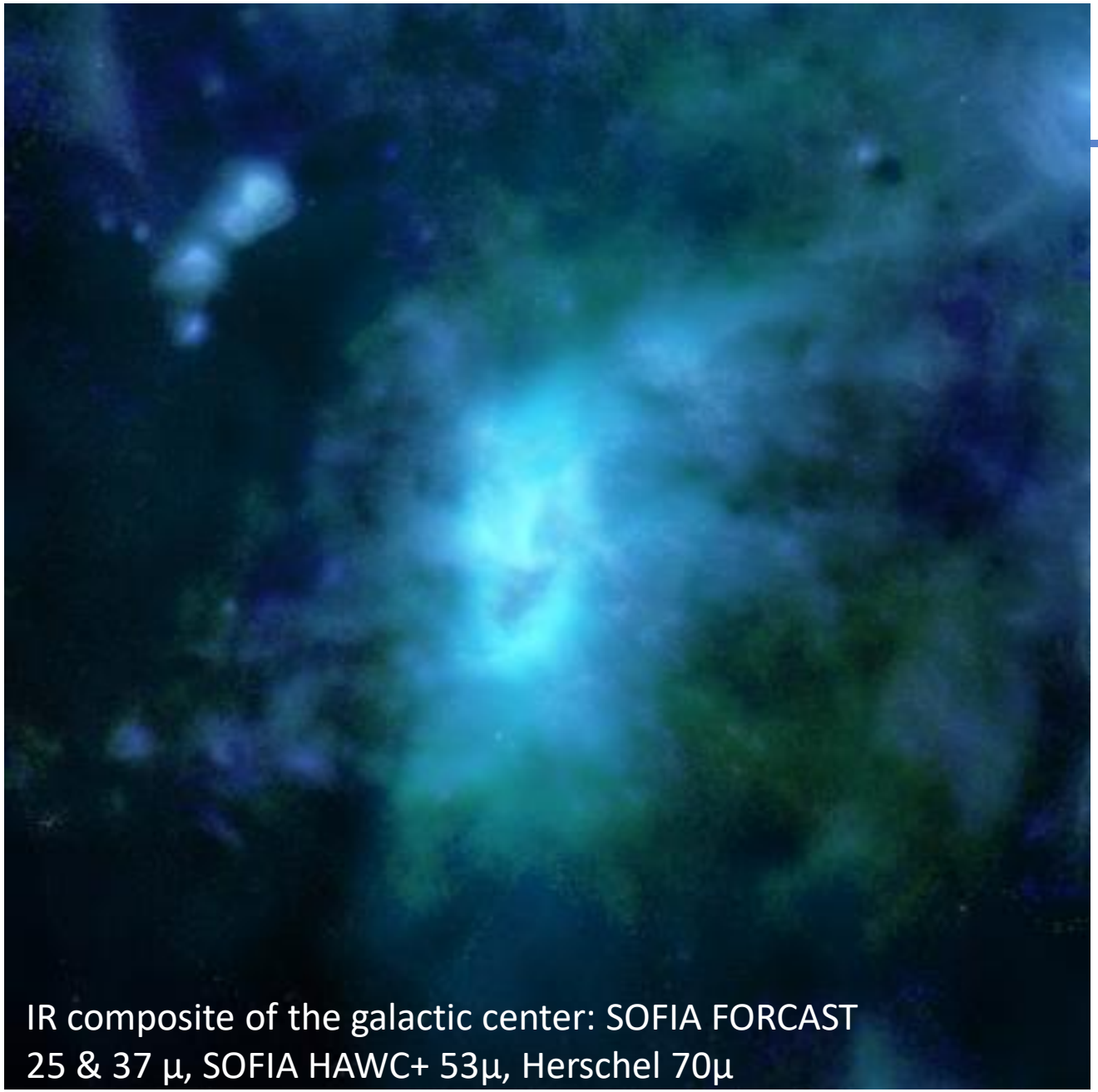
HD → MHD
Astronomy Disciplines

- Radio Jets
- Solar Physics
  - Star Formation
  - Interstellar Matter
    - Galaxies
    - Galactic Center

Plasma Beta

- $\beta = \dfrac{\text{thermal pressure}}{\text{magnetic pressure}}$
- If $\beta > 1$ (**high-β plasma**)
  - magnetic field may be present, but doesn't dominate
  - solar photosphere
- If $\beta < 1$ (**low-β plasma**), the
  - magnetic field dominates
  - solar corona

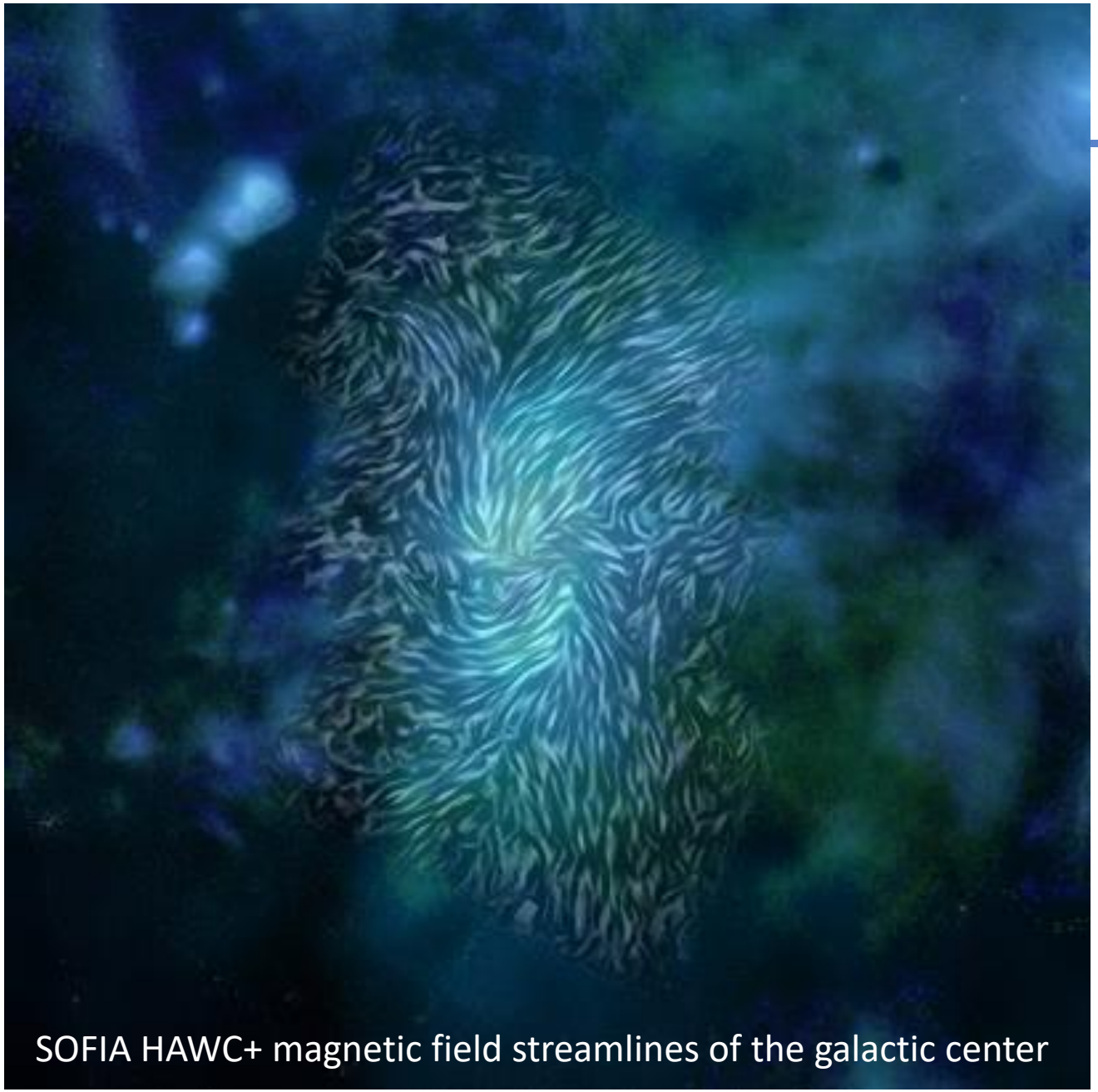




IR composite of the galactic center: SOFIA FORCAST 25 & 37 μ, SOFIA HAWC+ 53μ, Herschel 70μ

Results for Sagittarius A

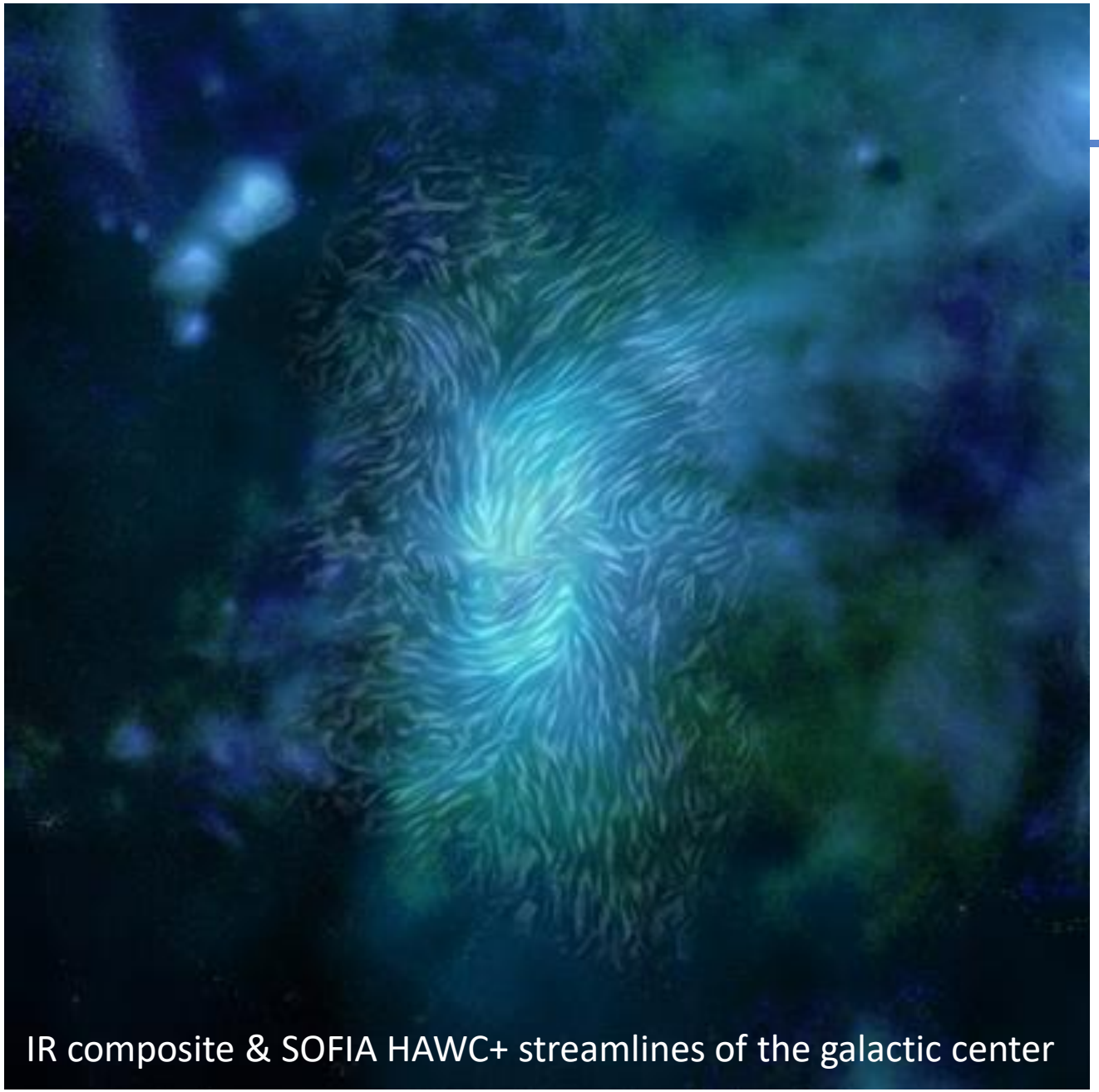
- $\beta = \frac{\text{thermal pressure}}{\text{magnetic pressure}}$
- **Temperature = 300 K** (Requena-Torres et al. 2012)
- **Density = 10^4 cm^{-3}** (Mills et al. 2017)
- **Magnetic Field = 5 mG** from the Davis-Chandra-sekhar-Fermi (DCF) method
- **β ~ .001**



SOFIA HAWC+ magnetic field streamlines of the galactic center

Results for Sagittarius A

- Observations tell us that turbulence is important in this region
- Traditional β does not account for this
- So we define β' as the ratio of the turbulent-to-magnetic pressure
- Using values from the literature
- **β' ~ 0.03.**



IR composite & SOFIA HAWC+ streamlines of the galactic center

Results for Sagittarius A

- These values are in the low-beta regime where the magnetic pressure dominates
- They indicate that, like the solar corona, the magnetic field could be
  - channeling the plasma
  - a significant force on the matter in this region
- Speculation
  - Star Formation
  - Active Galactic Nuclei

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