The Radio Emission of Cold M Dwarfs

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Ultracool Dwarfs

- Large enough to fuse hydrogen
- Too small for convective and radiative layers
- $0.075M_\odot$ - $0.14M_\odot$
- $0.08R_\odot$ - $0.2R_\odot$
- $T_{\text{eff}}$: 2300K - 2800K ($T_\odot = 5800$K)
The Güdel-Benz Relation

- Empirical relationship between X-ray and radio luminosity
- Holds well for F ~ early-M stars
- Drastically underpredicts radio luminosity (or overpredicts X-ray luminosity) of some UCDs
What causes radio emission in ultracool M dwarfs?

Auroral Emission

Gyrosynchrotron Radiation

Magnetic field accelerates electron by curving its path. Electron radiates as a result.
How can you distinguish between the two mechanisms?

Can’t look here

Look here!
Gyrosynchrotron Radiation

Indicative of accelerated electrons & high-energy particles incident on the surrounding planets

- High-energy particles most harmful to atmospheres of surrounding planets
- Bad news for potential life!
Implications for Habitability

- Most terrestrial planets orbit M-dwarf stars
- High flare rates, strong flares, and magnetic activity can impact the surrounding planets
- Strong magnetic fields could potentially strip planets of their atmospheres
- High-energy particles can more efficiently erode ozone
- Gyrosynchrotron emission ‘signature’ of high-energy particles
TRAPPIST-1 System

- 7 Earth-like planets
- 3 in the habitable zone
  - region capable of supporting liquid water
- High-interest system
  - discovery paper cited 421 times
My Observations

- ALMA observations at 95.7 GHz and VLA observations at 45 GHz both non-detections
- Conclusion: TRAPPIST-1 planets not overtly threatened
Radio survey of ultracool dwarfs

>100 ultracool M dwarfs observed and unpublished!

- At 30-100 GHz, gyrosynchrotron emission dominates
- Out of ~200 cold dwarfs observed at radio frequencies (8GHz), only 25 have been detected
- Only 1 detection of a cold dwarf at >30 GHz (out of two observed stars)
Questions?