

Extragalactic Magnetar Flares & Fast Radio Bursts

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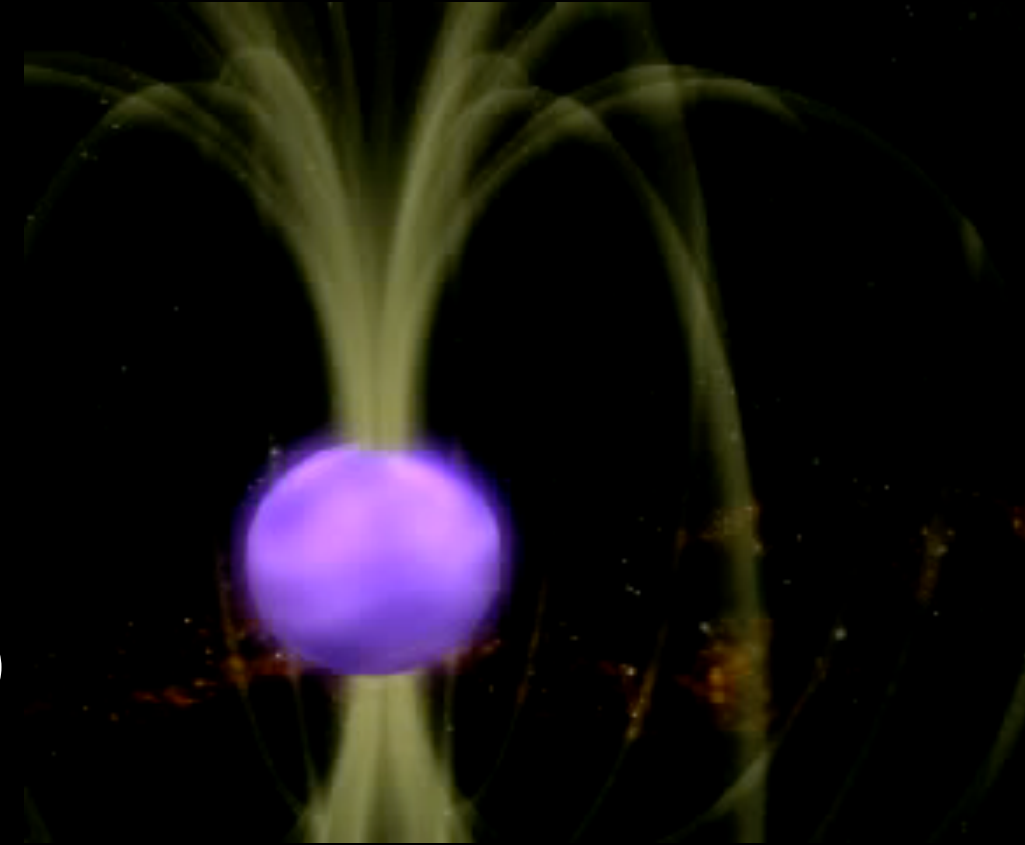
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Magnetar Giant Flares

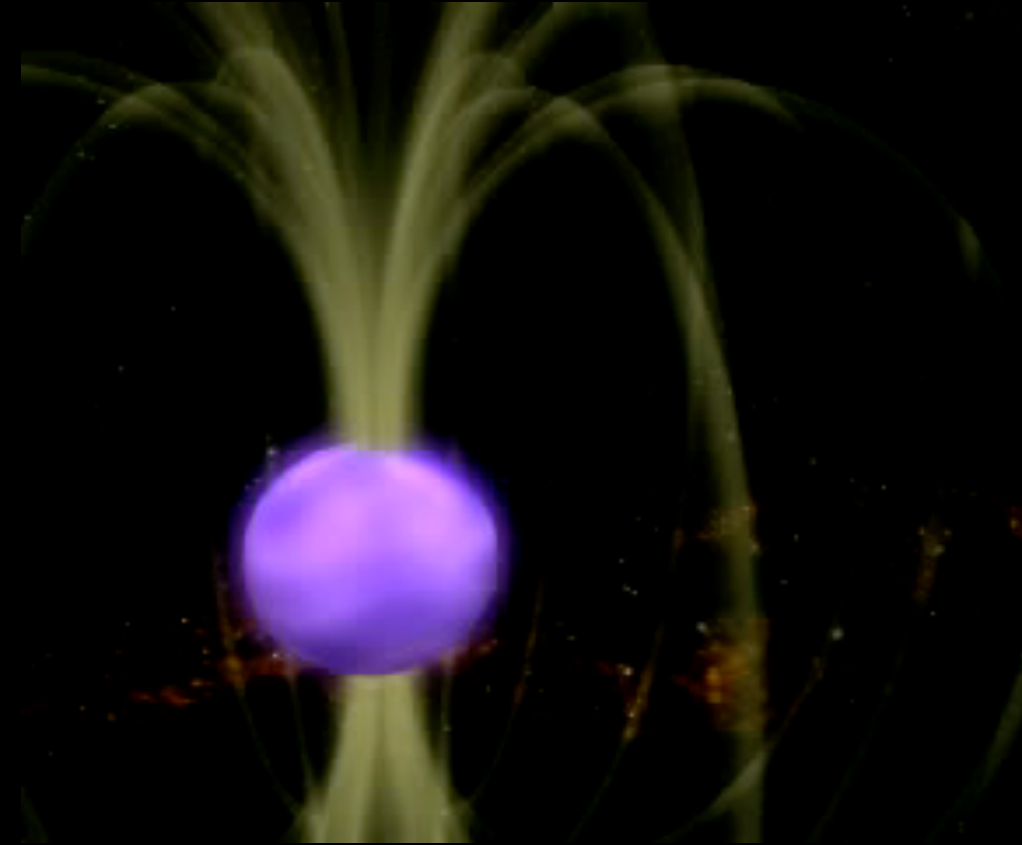
- Approximately 2 dozen magnetars known in the Milky Way/outskirts: rare!
- See McGill Online Magnetar catalog
<http://www.physics.mcgill.ca/~pulsar/magnetar/main.html>
- Three have shown giant flares:
 - SGR 0525-66 in 1979 (in Large Magellanic Cloud)
 - SGR 1900+14 in 1998
 - SGR 1806-20 in 2004
- Massive explosions:
 - **outshine entire cosmic hard X-ray/soft gamma-ray sky for brief instant!**
 - **Large but brief impact on Earth's ionosphere from clear across the Galaxy!**



Courtesy NASA/GSFC

Magnetar Giant Flares

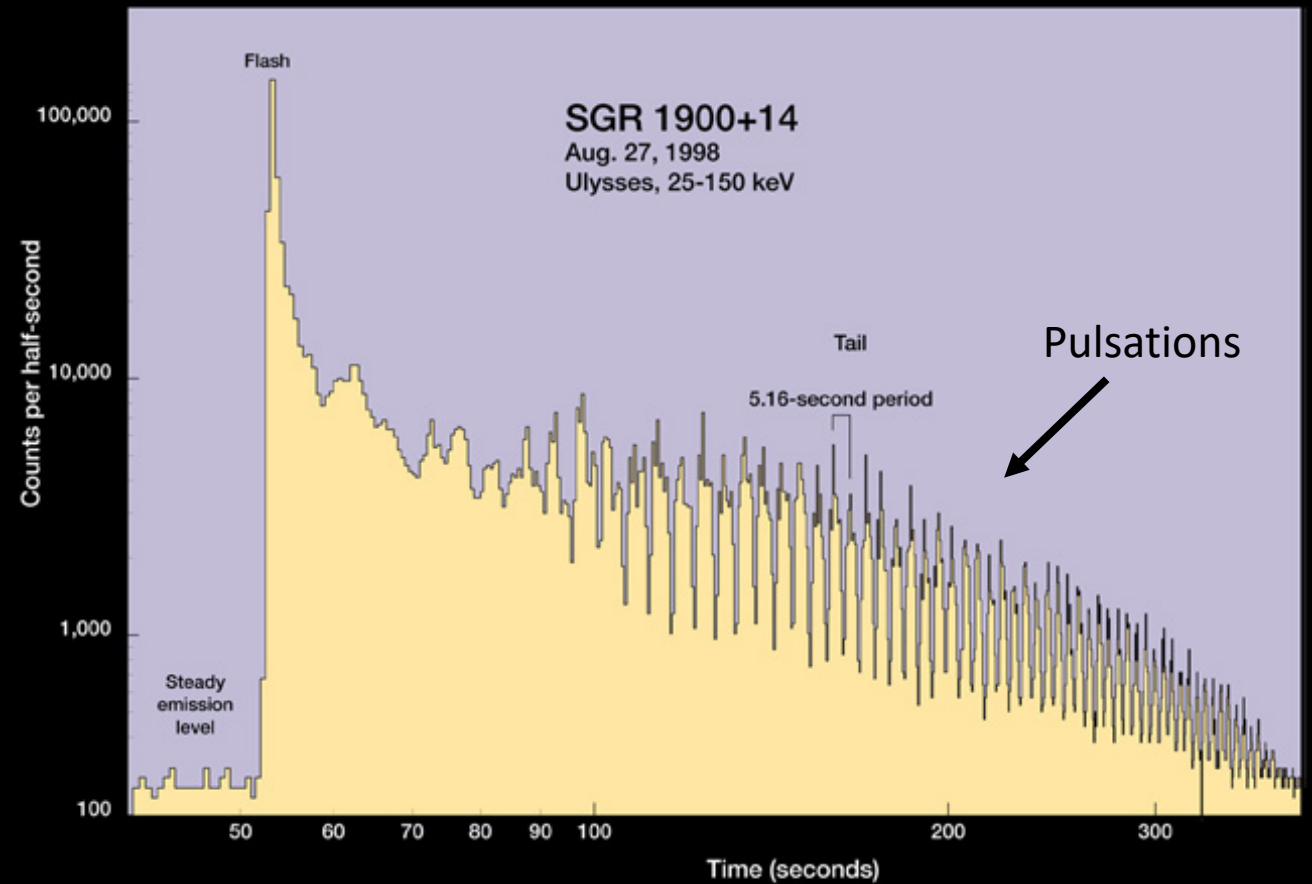
- **Outstanding Questions:**
 - Do all magnetars exhibit GFs?
 - Can a magnetar exhibit multiple GFs?
 - Why don't we see extragalactic GFs?



Courtesy NASA/GSFC

Extragalactic Magnetar Giant Flares

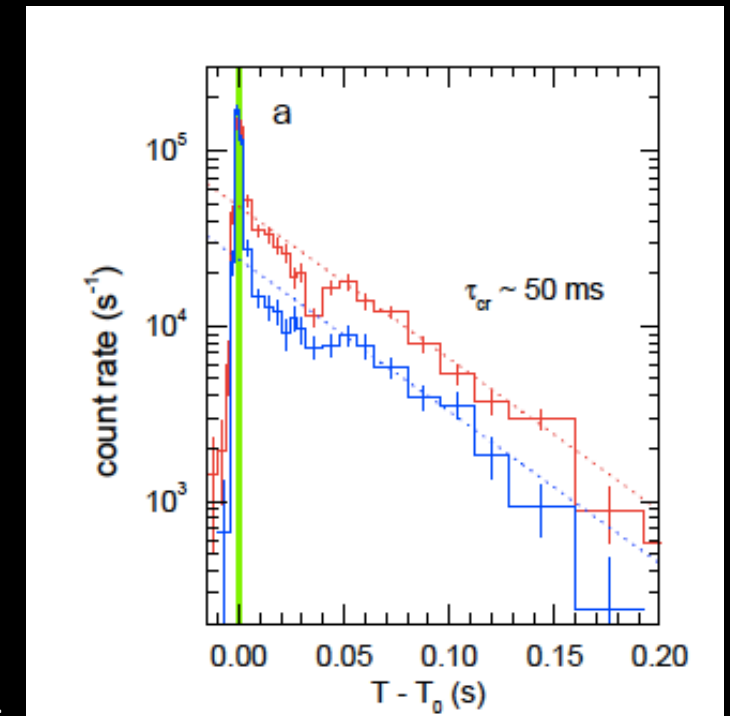
- Given Milky Way MGFs, certainly bright enough to detect to ~ 50 M lit yr
- Initial spike brightest \rightarrow most detectable
- Could be detected as a short gamma-ray burst (SGRB)
- Past speculation of detections of extragalactic MGFs, e.g.
 - M31 (Ofek et al. 2008)
 - M81/M82 (Hurley et al. 2010)
- **Today:** detection of GRB 200415A & its similarity to other apparent SGRBs demonstrates existence of extragalactic MGFs



Courtesy NASA/MSFC

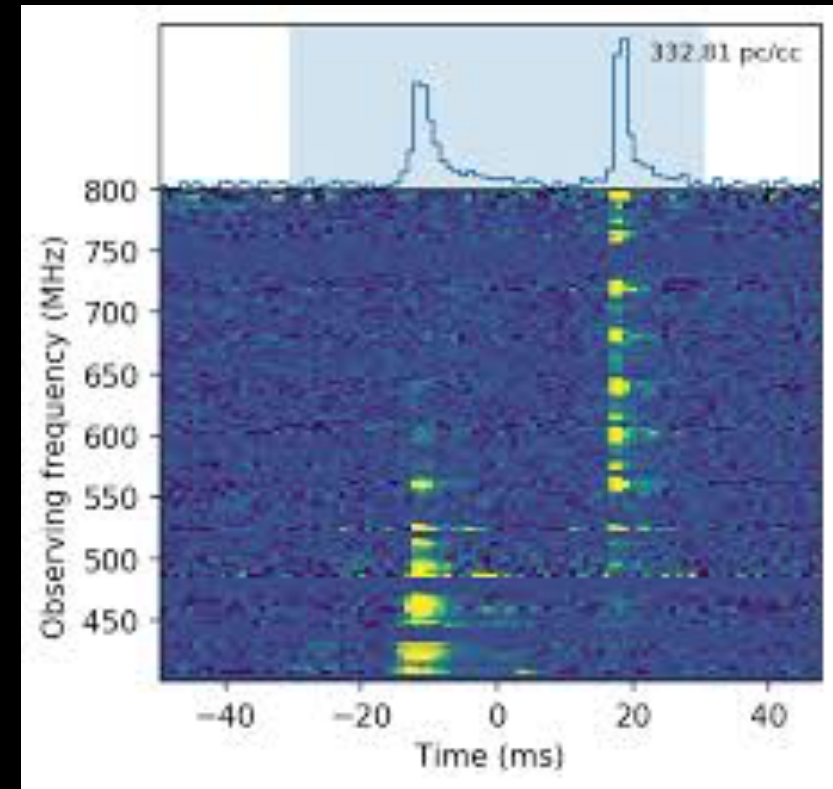
Extragalactic Magnetar Flares: Case Closed?

- Is the discovery a “smoking gun” ?
 - Not quite:
 - want detection of pulsations to absolutely prove NS existence
 - Want repeat burst to ensure not cataclysmic event
 - But do MGFs repeat??
- But it’s a clear “fingerprint” at the crime scene:
 - Burst morphology: initial spike, relaxation, spectral evolution
 - Absence of gravitational waves yet so nearby
 - In star-forming galaxy
 - Delay to very high energy gamma rays
 - though unknown if MW MGFs show VHE emission?



Fast Radio Bursts

- Brief (few ms) bursts of radio waves
- Arriving from outside Milky Way
 - Most from cosmological distances
- Some repeat
- Origins unknown
- One FRB-like event discovered in April 2020 from MW magnetar (CHIME/FRB Collaboration et al. Nature, 2020; Bochanek et al. Nature, 2020)
- Today's results support that many/all? FRBs could originate from extragalactic magnetars: Burns et al. birthrate high enough!
- **BUT problems!** energetics; different FRB classes; no FRB/MGF seen...



Summary

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- **Extragalactic magnetars exist!**
- Confirmation of long-standing expectations given observations of Galactic magnetars
- Opens new questions:
 - MGF Repeatability?
 - MGF VHE emission?
- Implications for Fast Radio Bursts: still open questions!

Thank you!