# A Population of Extragalactic Magnetar Giant Flares

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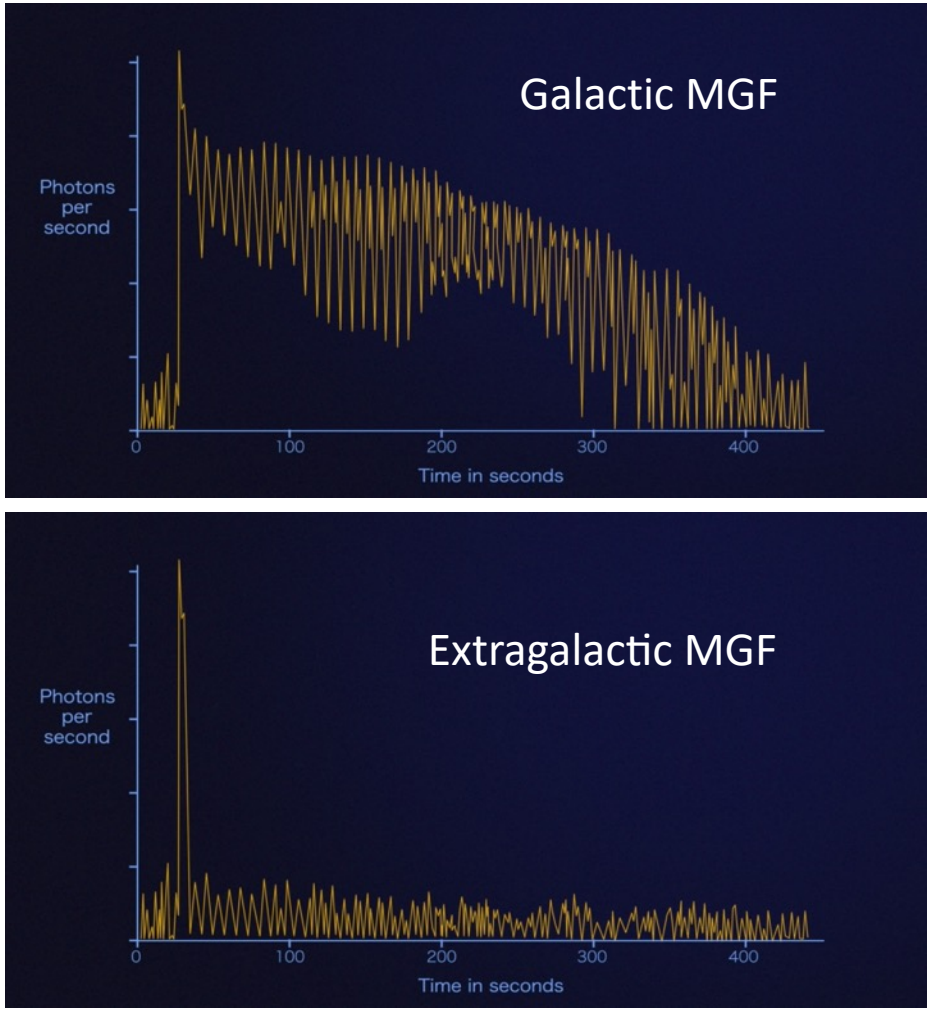
**On behalf of many scientists**

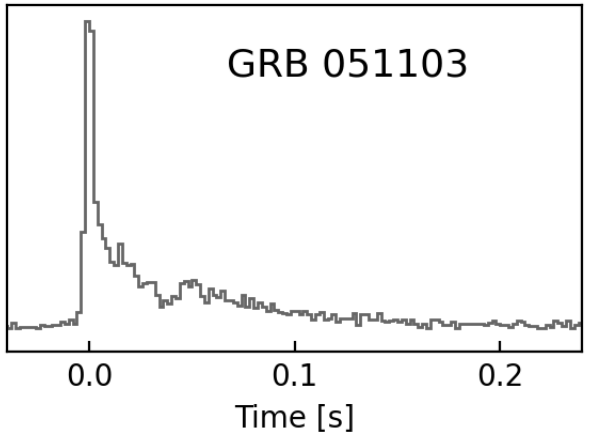
# Extragalactic Magnetar Giant Flares as Gamma-Ray Bursts?

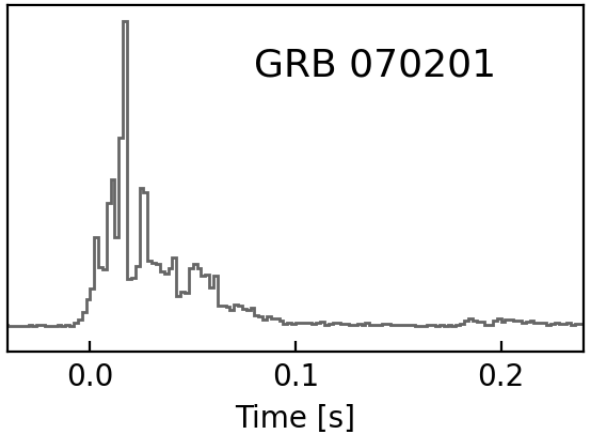
- We know GRBs come from neutron star mergers and collapsars. Can we prove we detect distant MGFs as GRBs?
- With current instruments we cannot detect the ‘smoking-gun’ signature to these distances
- We have to rely on spatial alignment studies, so **we checked 250 short GRBs for alignment with nearby galaxies**

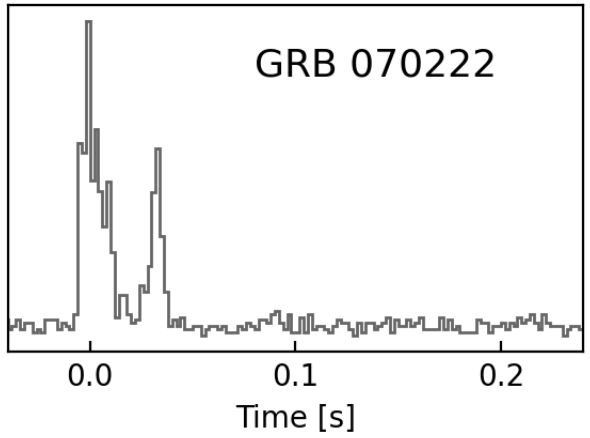


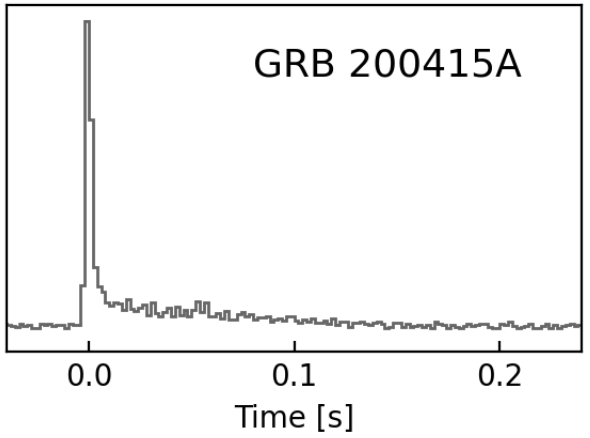

Credit: NASA Goddard/S. Wiessinger

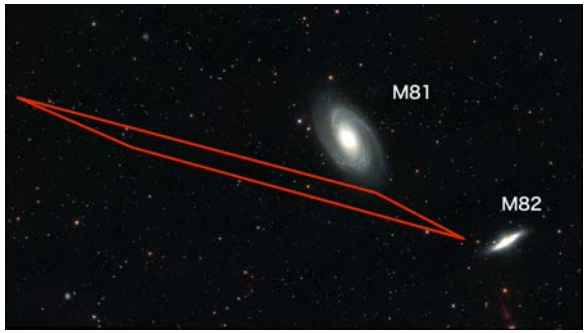
# Four local GRBs, their host galaxies, and the odds of chance alignment

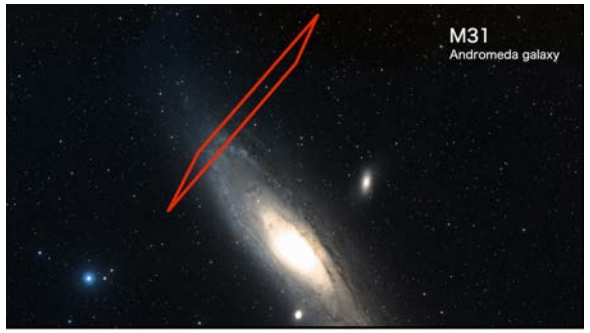


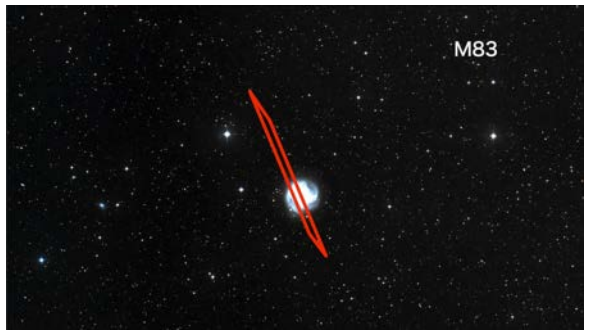



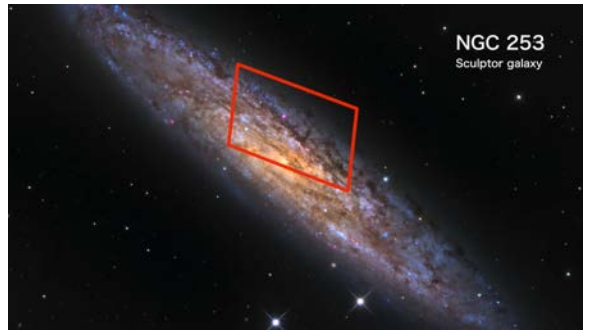




1 in 70,000

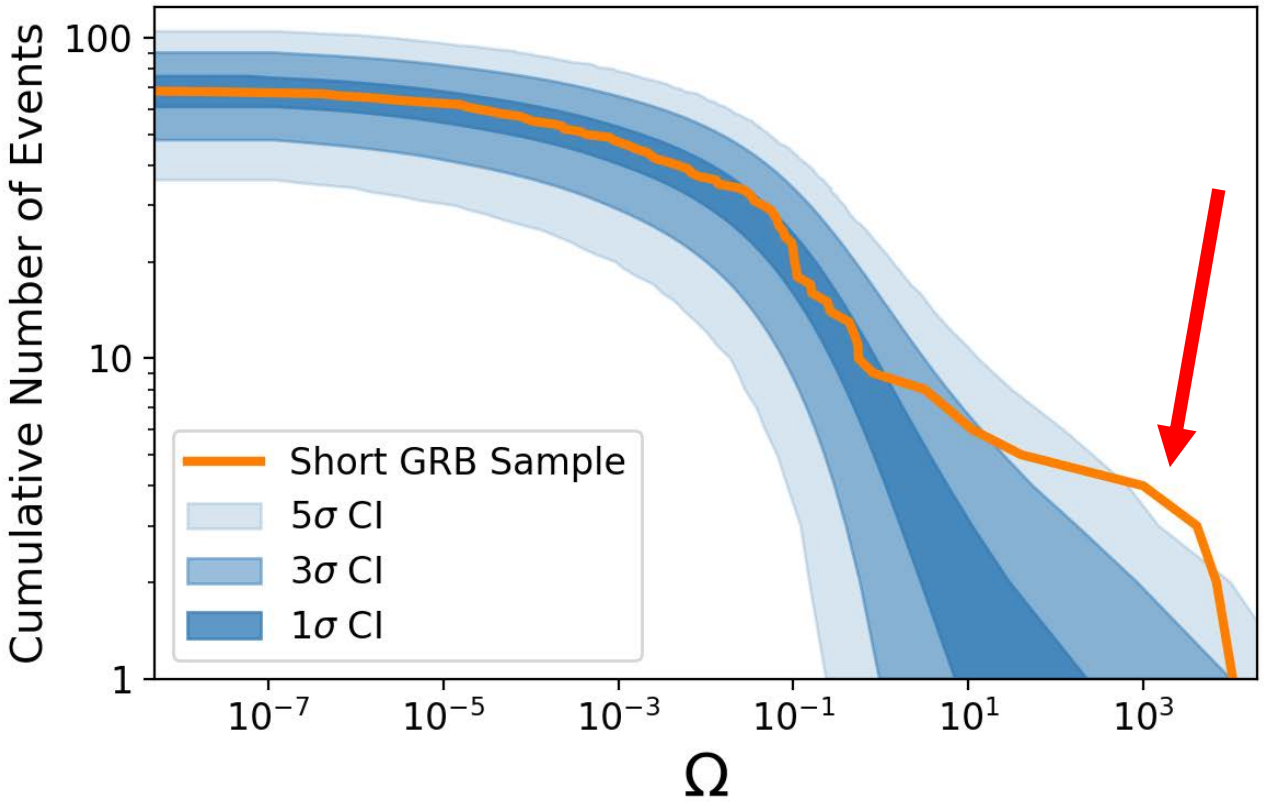
1 in 10,000

1 in 130,000

1 in 230,000

# Extragalactic Magnetar Giant Flares

- Simulations with our full sample of 250 short GRBs rarely produces 4 events this significant.
- They have no associated supernovae or gravitational wave signals.
- All 4 have very short durations, sharp rise times, and total energetics consistent with an MGF origin.



# What does this tell us?

- We have identified only 7 magnetar giant flares, but with this sample we can now constrain their intrinsic energetics, and thus how far we can detect them.
- Accounting for this, Magnetar Giant Flares are (probably) the most common high-energy transients so far detected beyond the Milky Way

| Event | Local Rates ($Gpc^{-3}$ $yr^{-1}$) |
|---|---|
| Magnetar Giant Flares | 380,000 |
| Neutron Star Mergers (short GRBs) | 320[a] |
| Collapsars (long GRBs) | ~100[b] |
| Superluminous Supernovae | ~20[c] |
| Type Ia Supernovae | 30,100[d] |
| Type Ibc Supernovae | 25,800[d] |
| Type II Supernovae | 44,700[d] |

a – LSC 2020 arXiv:2010.14527
b – D. Siegel, et al. 2019 Nature 569, 241
c - S. Prajs, et al. 2017 MNRAS 464, 3
d – W. Li, et al. 2011 MNRAS 412, 3

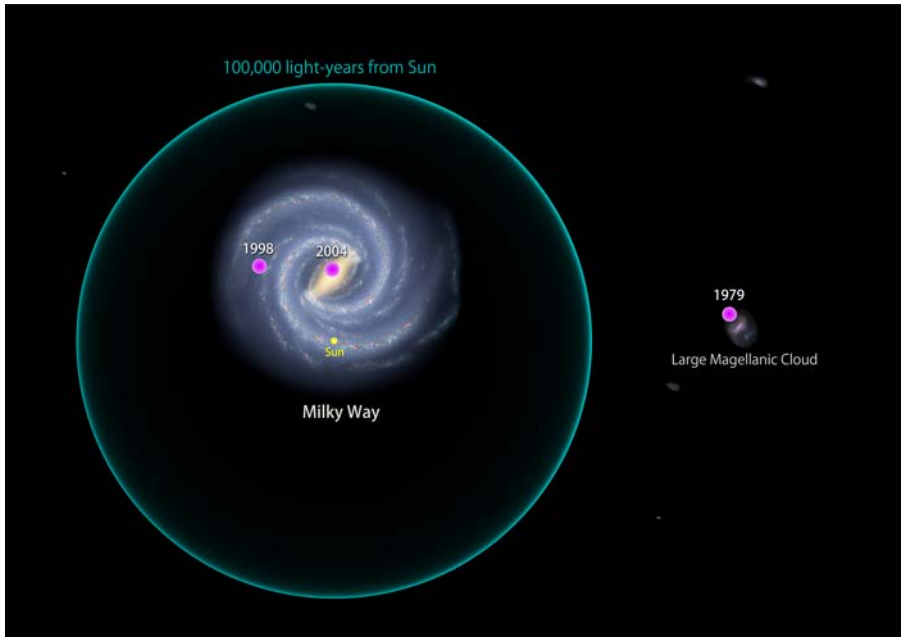
# What does this tell us?

- Since the discovery of GRBs it was debated if they repeated. Since the late 90s the answer was ‘no’, but our result predicts magnetars as GRB repeaters
- First strong observational evidence requiring that normal core-collapse supernovae create magnetars

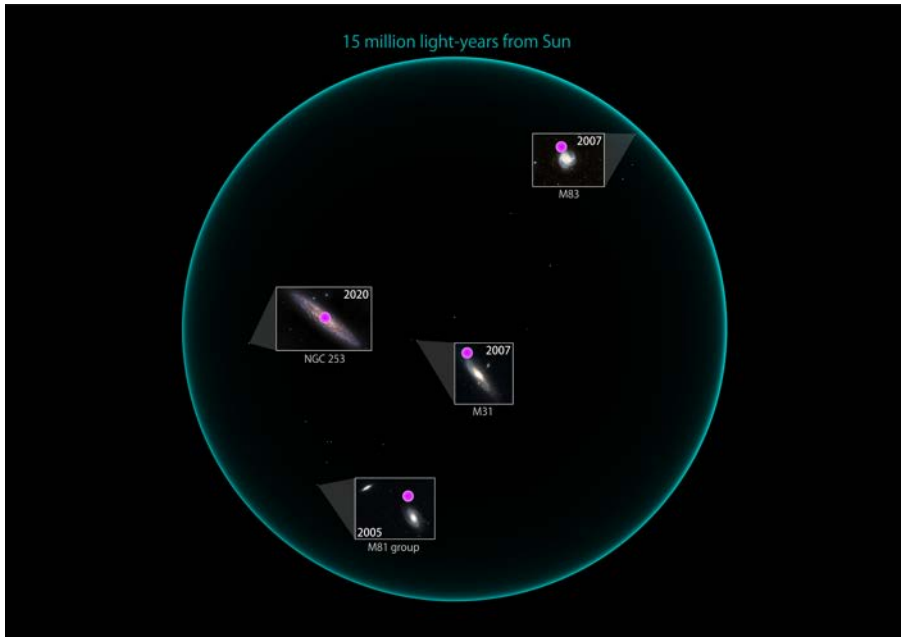
Credit: NASA Goddard/S. Wiessinger, K. Hurley

# What else could we learn?

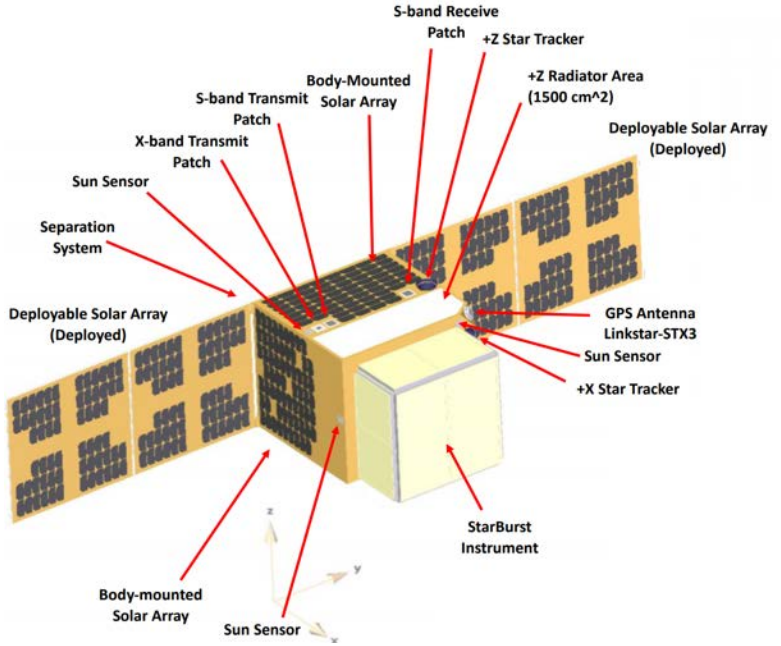
1960s-1990s:




1990s-2010s:




StarBurst – Selected for a non-competitive Phase A




See Also:

COSI – J. Tomsick 315.01

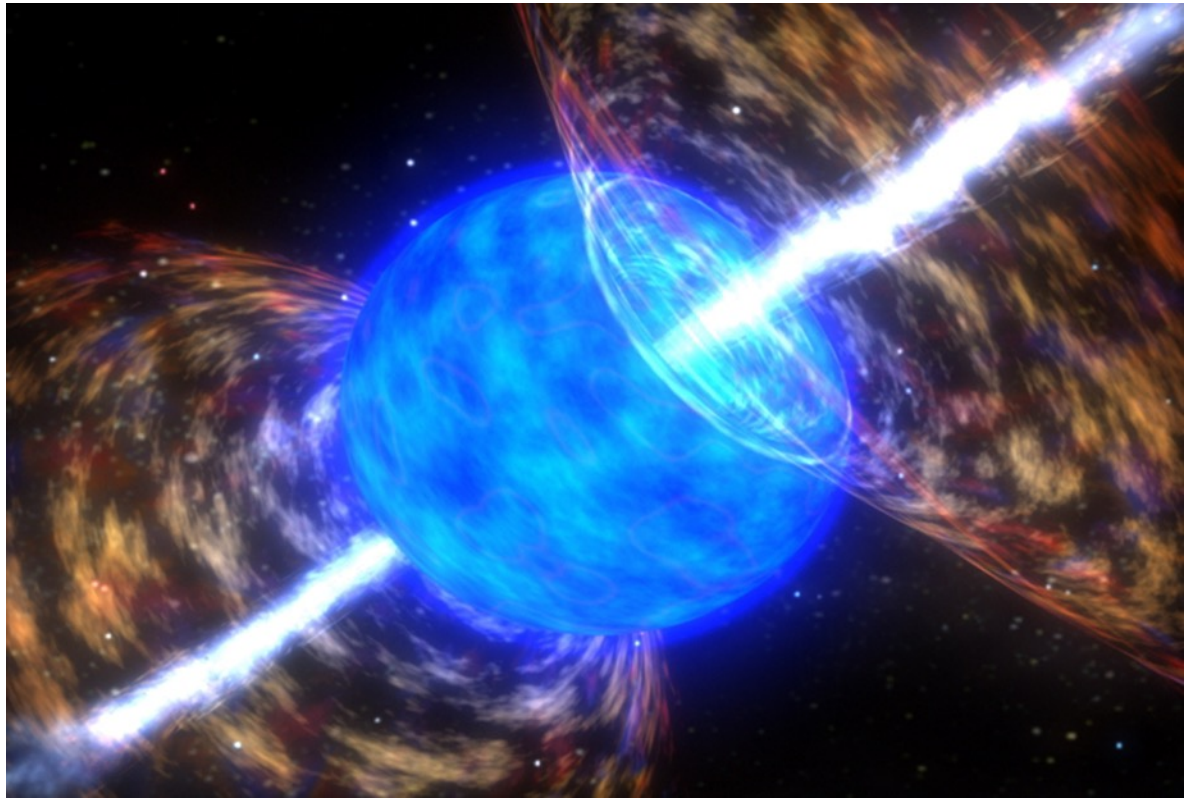
Moonbeam – C. M. Hui 315.02

AMEGO – C. Kierans 315.04

# Other slides

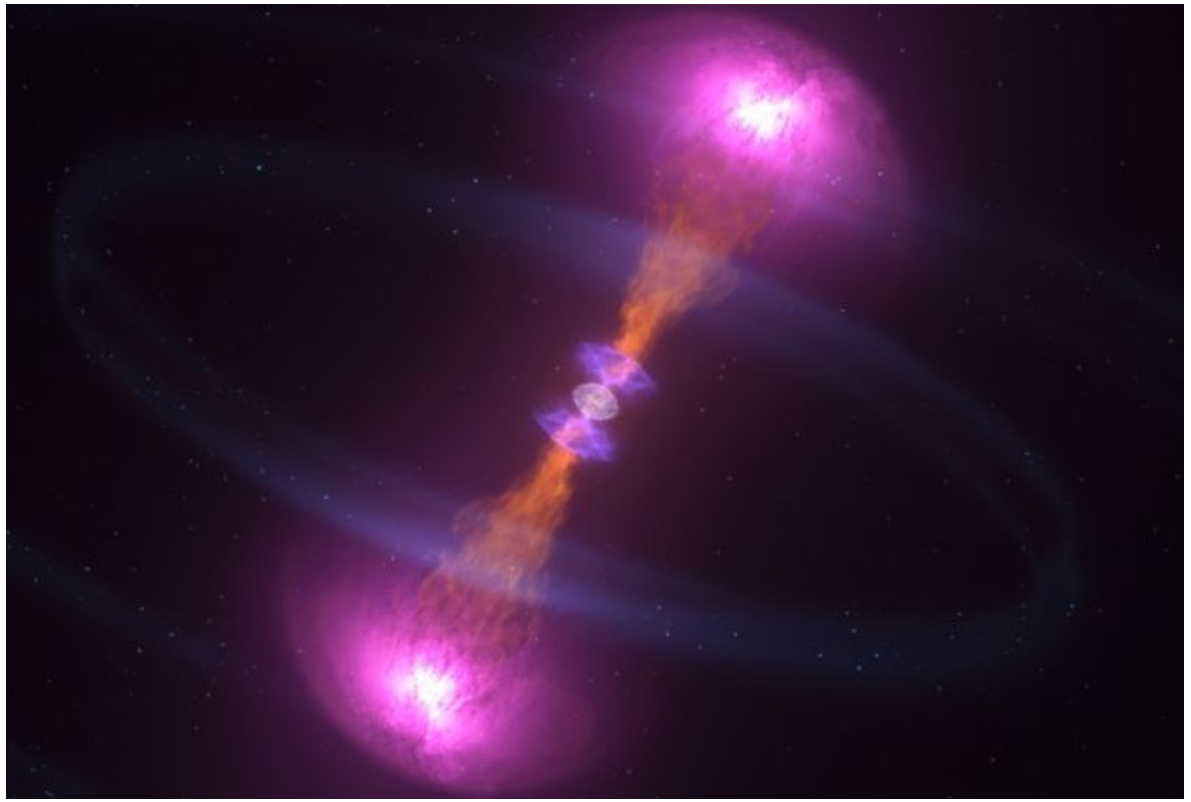
# Known Progenitors of Gamma-Ray Bursts

Credit: NASA/SkyWorks Digital

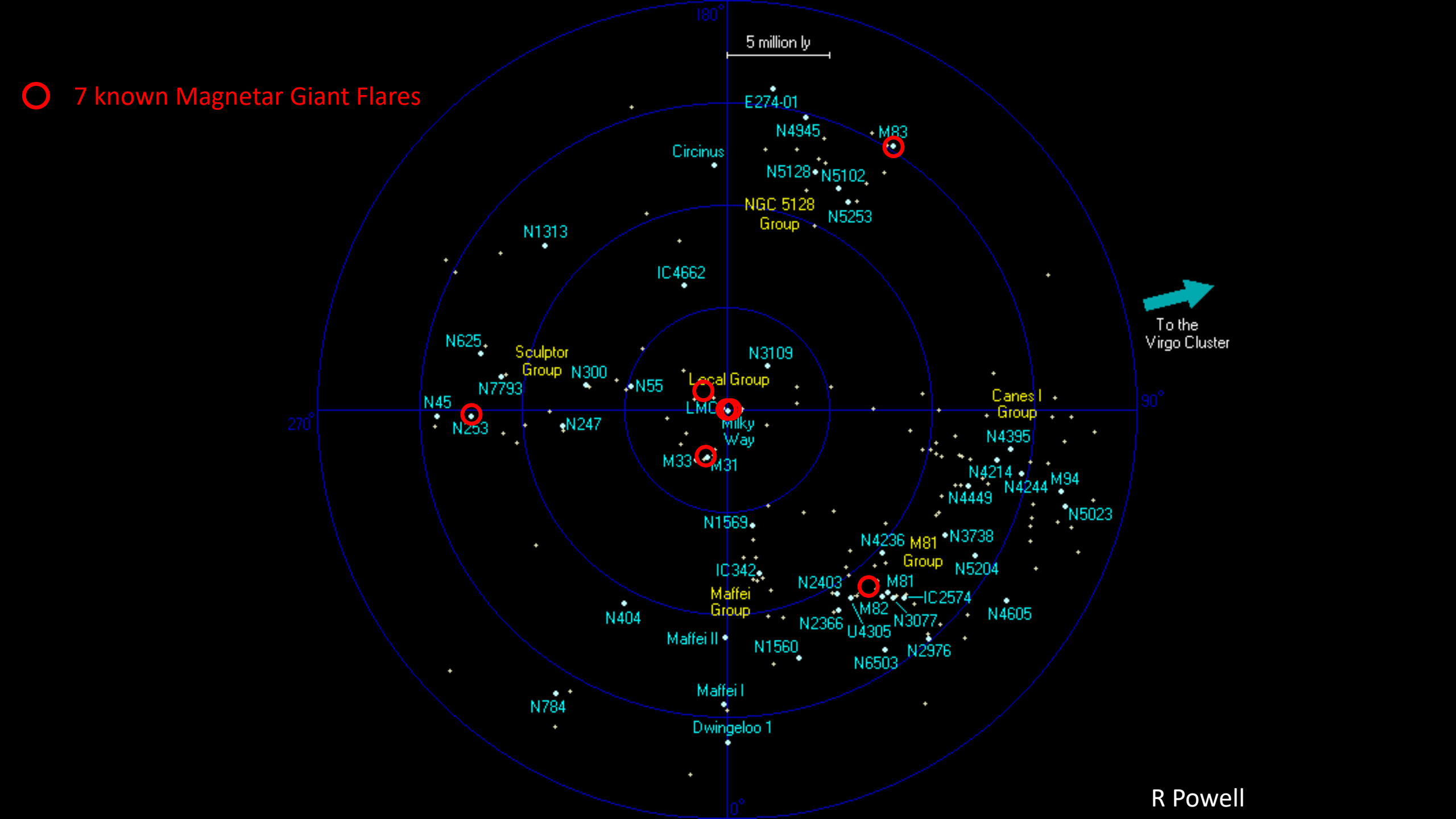


1998: Long GRBs come from a rare type of core-collapse supernova, proven by BeppoSAX and follow-up observations.

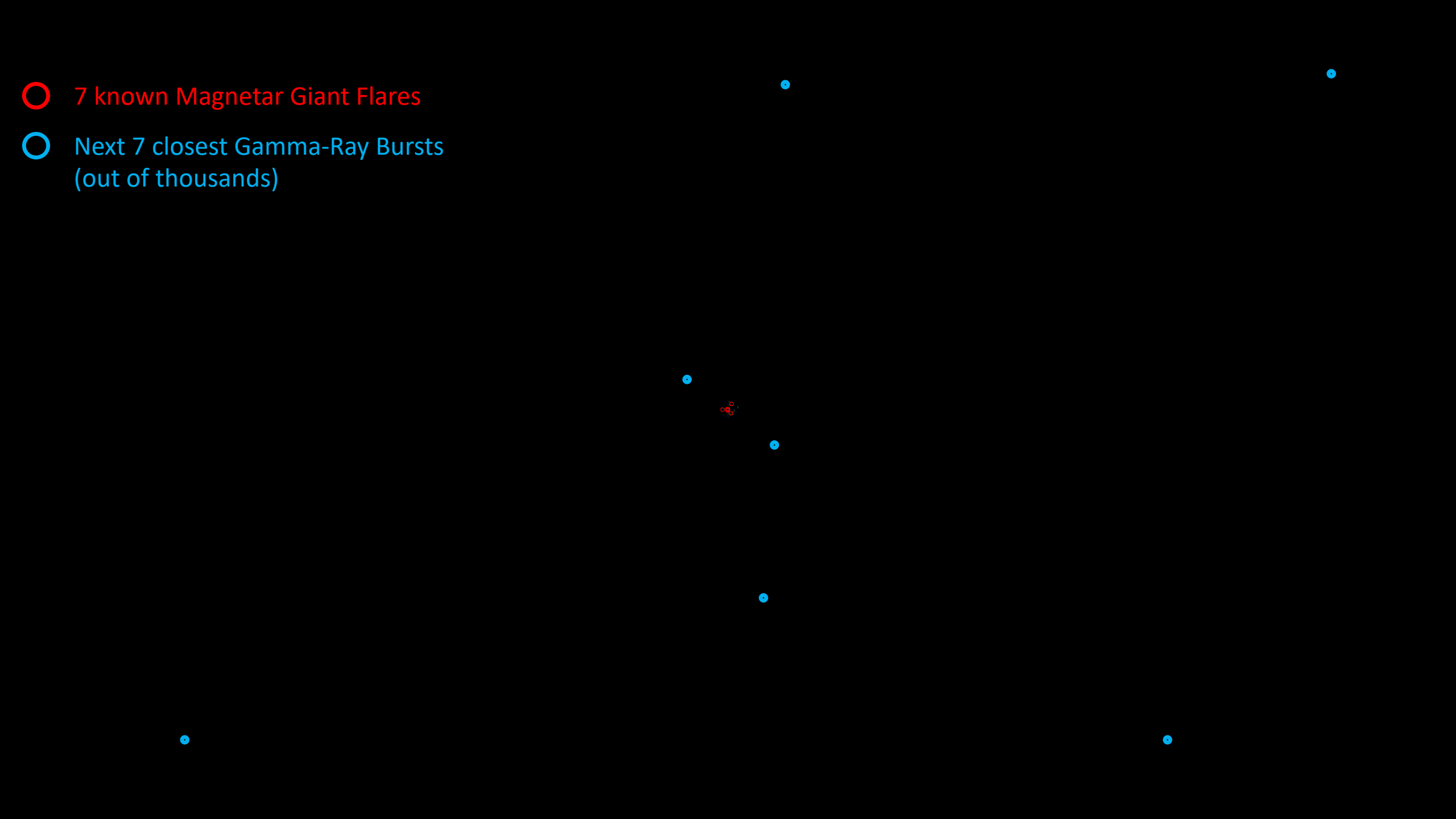
Credit: NASA Goddard / CI Lab



2017: Short GRBs come from neutron star mergers, proven by LIGO, Virgo, Fermi, and INTEGRAL.


7 known Magnetar Giant Flares
180°
5 million ly
E274-01
N4945
M83
Circinus
N5128
N5102
NGC 5128
Group
N5253
N1313
IC4662
To the
Virgo Cluster
N625
Sculptor
Group
N300
N3109
N7793
N55
Local Group
N45
LMC
90°
270°
N253
N247
Milky
Way
Canes I
Group
N4395
M33
M31
N4214
N4244
M94
N4449
N5023
N1569
N4236
M81
N3738
Group
IC342
N5204
N2403
M81
IC2574
Maffei
Group
M82
N404
N2366
N3077
N4605
U4305
Maffei II
N1560
N2976
N6503
Maffei I
N784
Dwingeloo 1
0°

R Powell


7 known Magnetar Giant Flares
Next 7 closest Gamma-Ray Bursts
(out of thousands)