Magnetars!

K.E.Gardner

UTU - Department of Physics and Astronomy

What is a Magnetar?

Definition:

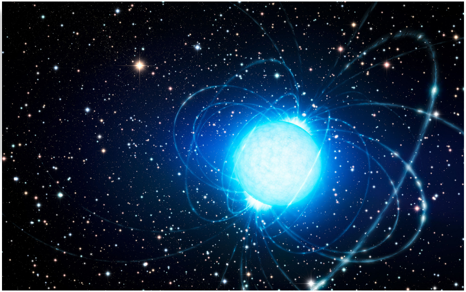

Figure: Artistic depiction of a magnetar

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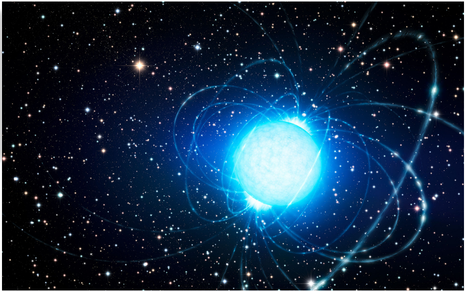

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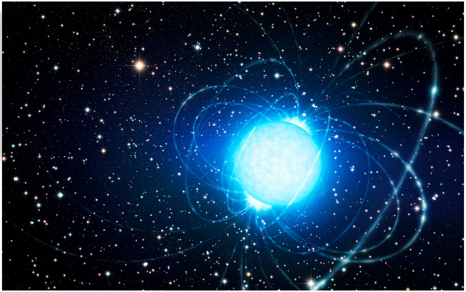
What is a Magnetar?

Definition:

- neutron star
- massive magnetic field ($\geq 10^{13}$ G)



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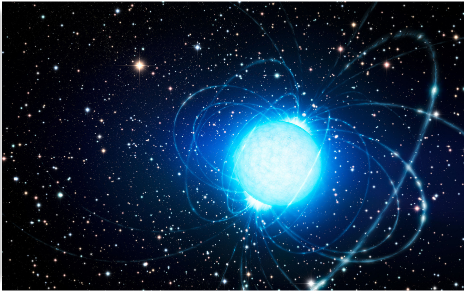

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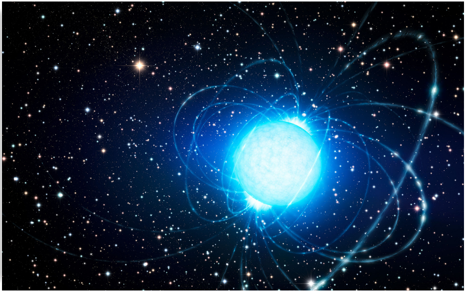

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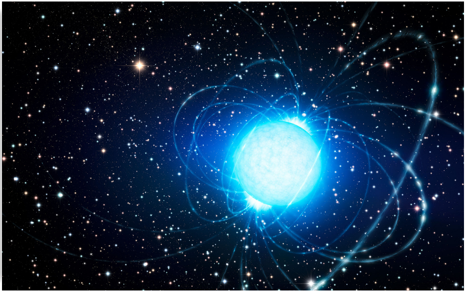

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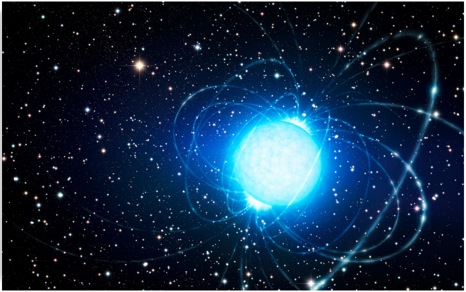

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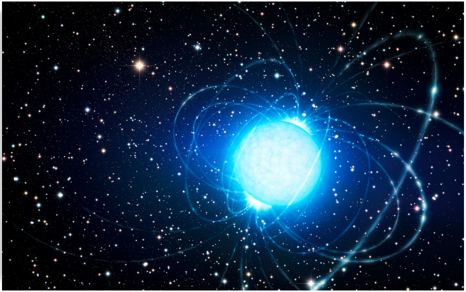

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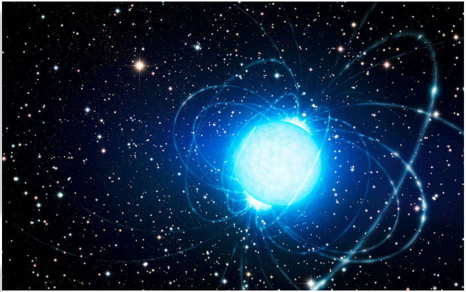
Cases:



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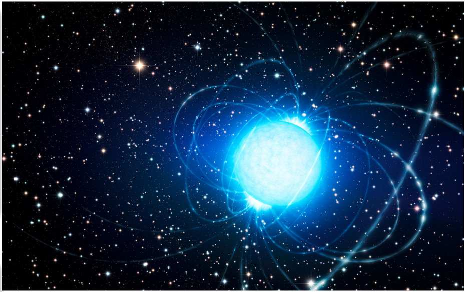

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Basic Properties

Description:

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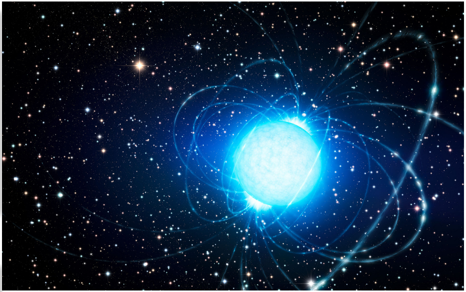

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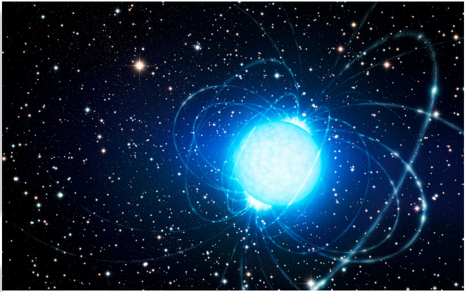

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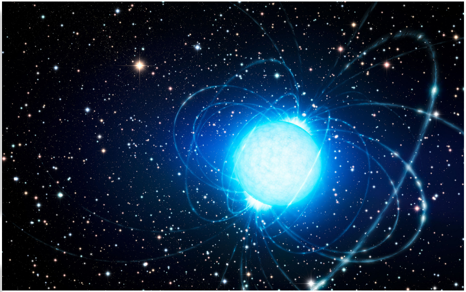

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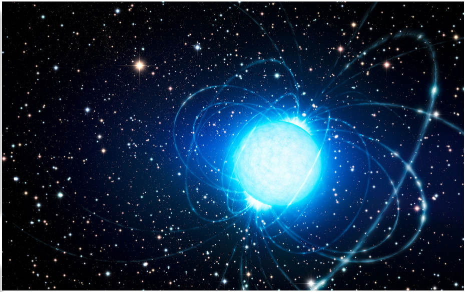

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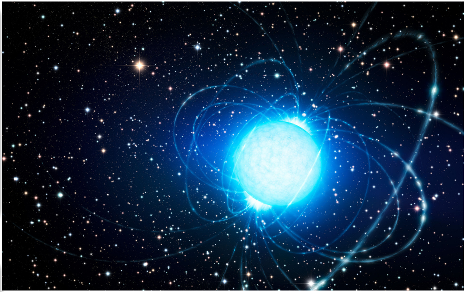
- cross-species magnetar/pulsar



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Distribution in Space

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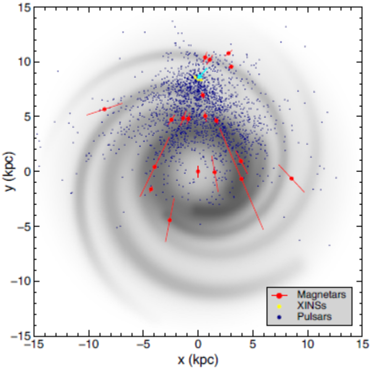

Figure: Top down view of the Milky Way with known Magnetars (and distance uncertainties) in red.

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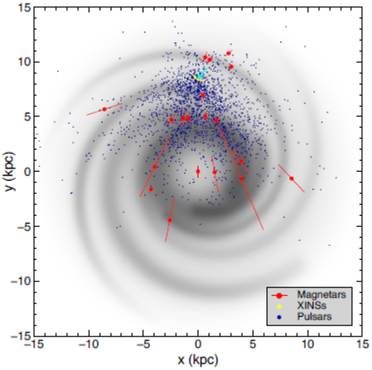

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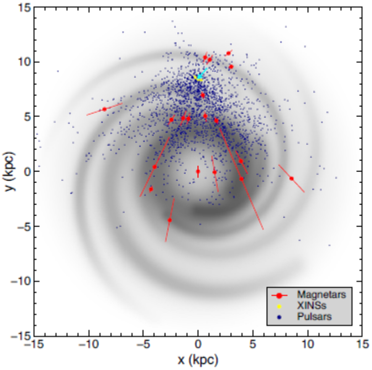

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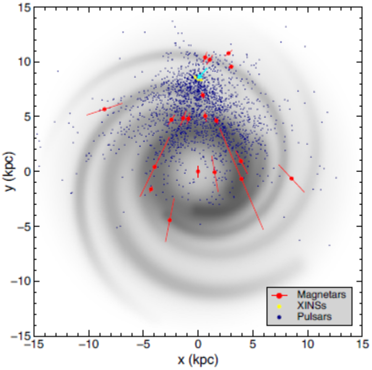

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Distribution in Space

Name	P (s)	B (10^{14} G)	Age (kyr)	E (10^{33} erg s^{-1})	D (kpc)	L (10^{33} erg s^{-1})	Band
CXOU J010043.1-721134	8.02	3.9	6.8	1.4	62.4	65	...
4U 0142+61	8.69	1.3	68	0.12	3.6	105	OIR/H
SGR 0418+5729	9.08	0.06	36000	0.00021	2	0.00096	...
SGR 0501+4516	5.76	1.9	15	1.2	2	0.81	OIR/H
SGR 0526-66	8.05	5.6	3.4	2.9	53.6	189	...
1E 1048.1-5937	6.46	3.9	4.5	3.3	9.0	49	OIR
(PSR J1119-6127)	0.41	4.1	1.6	2300	8.4	0.2	R/H
1E 1547.0-5408	2.07	3.2	0.69	210	4.5	1.3	O?/R/H
PSR J1622-4950	4.33	2.7	4.0	8.3	9	0.4	R
SGR 1627-41	2.59	2.2	2.2	43	11	3.6	...
CXOU J164710.2-455216	10.6	<0.66	>420	<0.013	3.9	0.45	...
1RXS J170849.0-400910	11.01	4.7	9.0	0.58	3.8	42	O?/H
CXOU J171405.7-381031	3.82	5.0	0.95	45	13	56	...
SGR J1745-2900	3.76	2.3	4.3	10	8.3	<0.11	R/H
SGR 1806-20	7.55	20	0.24	45	8.7	163	OIR/H
XTE J1810-197	5.54	2.1	11	1.8	3.5	0.043	OIR/R
Swift J1822.3-1606	8.44	0.14	6300	0.0014	1.6	>0.0004	...
SGR 1833-0832	7.56	1.6	34	0.32	...	...	...
Swift J1834.9-0846	2.48	1.4	4.9	21	4.2	<0.0084	...
1E 1841-045	11.79	7.0	4.6	0.99	8.5	184	...
(PSR J1846-0258)	0.327	0.49	0.73	8100	6.0	19	...
3XMM J185246.6+003317	11.56	<0.41	>1300	<0.0036	7	< 0.006	...
SGR 1900+14	5.20	7.0	0.9	26	12.5	90	H
SGR 1935+2154	3.24	2.2	3.6	17	...	...	...
1E 2259+586	6.98	0.59	230	0.056	3.2	17	OIR/H
SGR 0755-2933	...	...	...	...	...	...	...
SGR 1801-23	...	...	...	...	...	...	...
SGR 1808-20	...	...	...	...	...	...	...
AX J1818.8-1559	...	...	...	...	...	...	...
AX J1845.0-0258	6.97	...	...	...	...	2.9	...
SGR 2013+34	...	...	...	...	...	...	...

Supernova Remnant Associations

Basics:

Consequences:

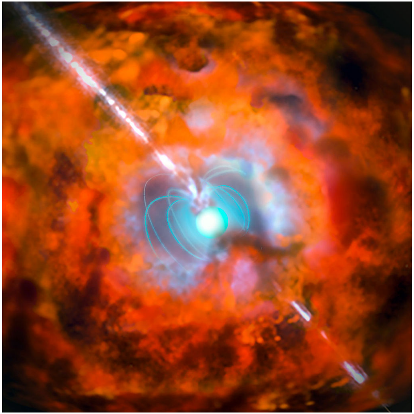

Figure: Artist's depiction of supernova remnant and magnetar [Cite here]

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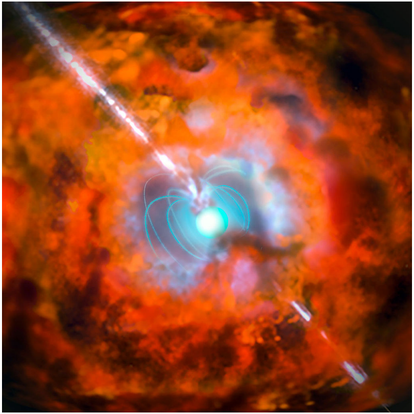

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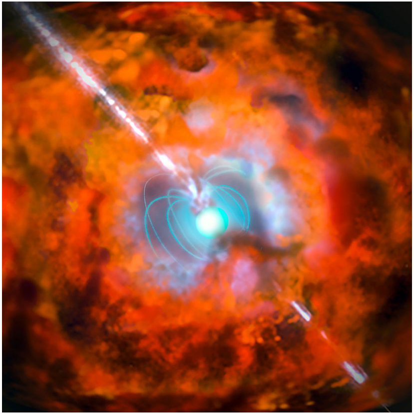

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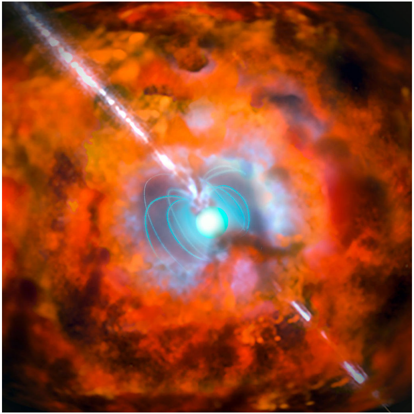

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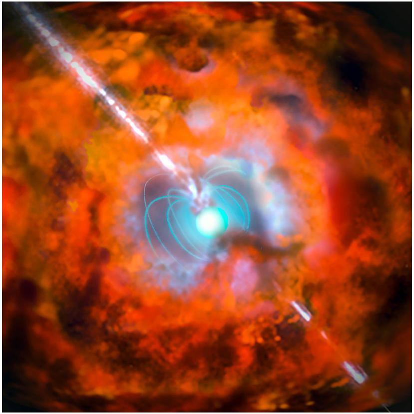

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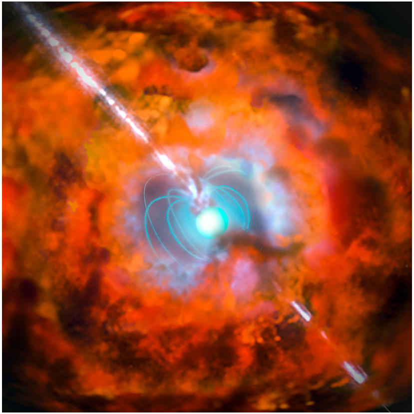

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Supernova Remnant Associations

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Consequences:

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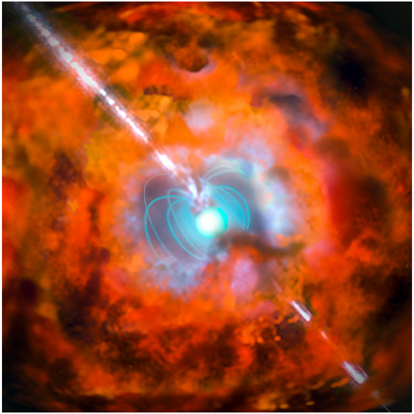
- challenges dynamo model and fossil field theory
- no conclusive theory of formation as of yet



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Formation

Theories

Common Conditions

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- Neutron stars with $\approx$ 1 ms period at birth [1]

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Distinctions

Magnetars

Radio Pulsars

Distinctions

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Radio Pulsars

- 100 ms rotational period

Distinctions

Magnetars

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- spin-down leads to quiescent X-ray emission and gamma-ray bursts

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Magnetars

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Radio Pulsars

- 100 ms rotational period
- spin-down causes radio emission, and non-thermal X/gamma-ray radiation

Distribution in Space

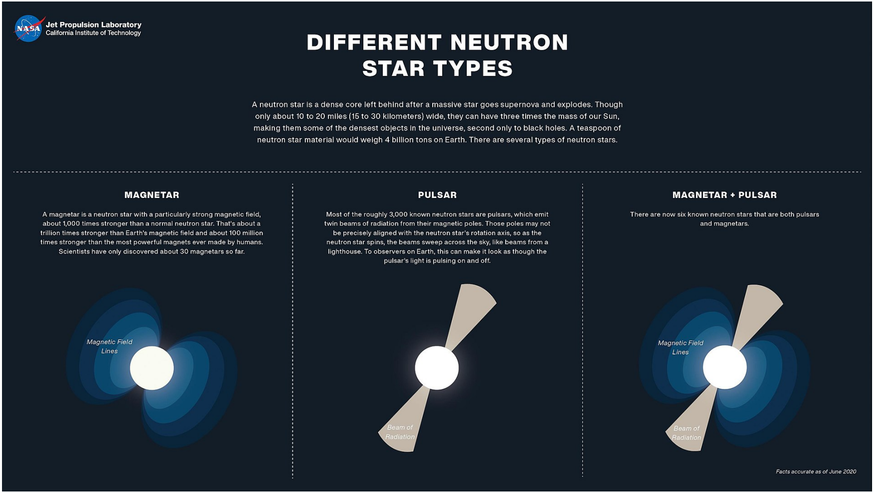

Figure: Neutron star types, courtesy of JPL [cite here]

Kinds of Magnetars

Bi-modal

Cross-species

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- Persistent Magnetars

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Cross-species

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- Theoretically: neutron star switch between magnetar, pulsar, and magnetar pulsar

Magnetic Breaking

Materials

Magnetic Breaking

Materials

-

EM-Bursts

EM-Bursts

-

Summary and Conclusions

What we know

What we don't know

Summary and Conclusions

What we know

-

What we don't know

Summary and Conclusions

What we know

-

What we don't know

- A definitive model for the formation of magnetars

Resources

-

References

1. Duncan RC, Thompson C. 1992. ApJ 392:L9-L13