Power Source for the Most Energetic Explosions in the Local Universe

Super-Luminous Supernova Gaia16apd

Posner Program

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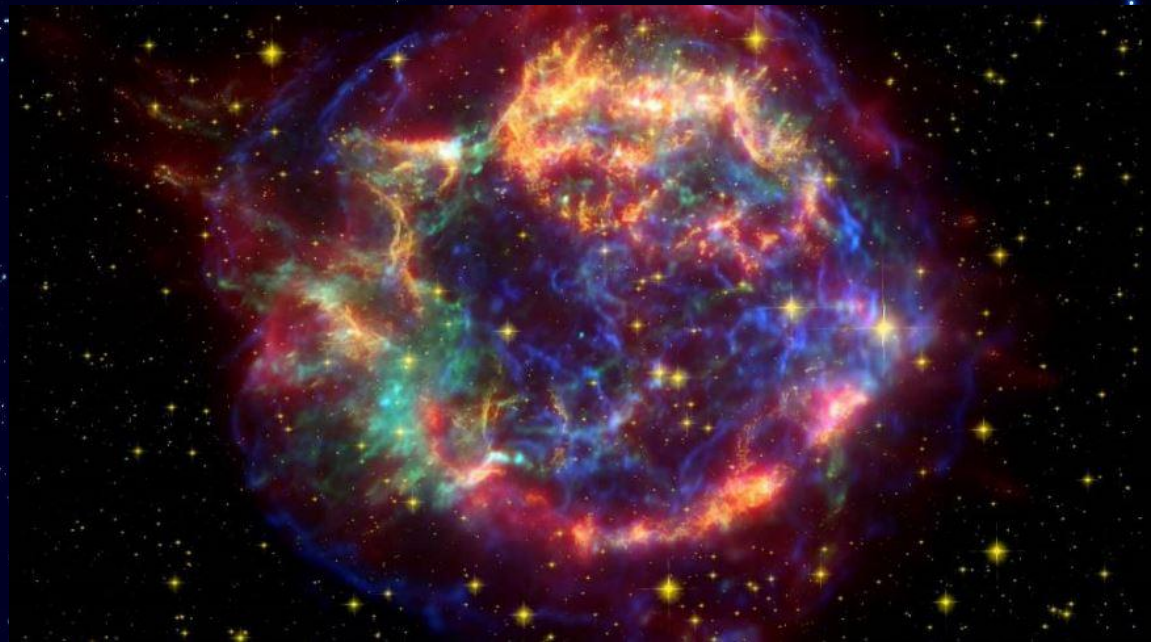
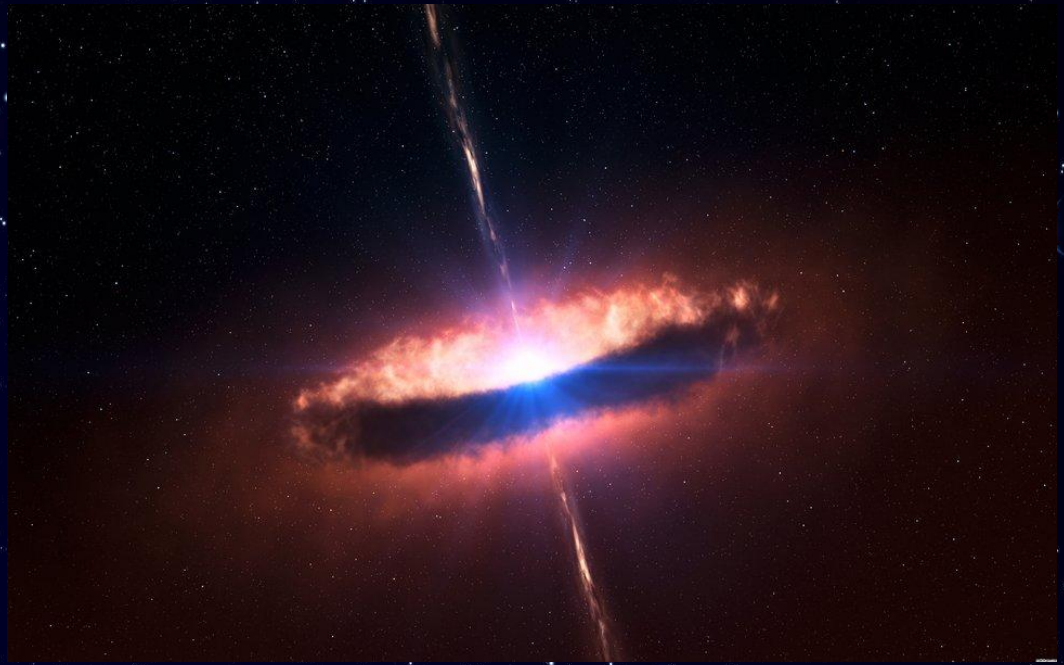


Evolution of a Star

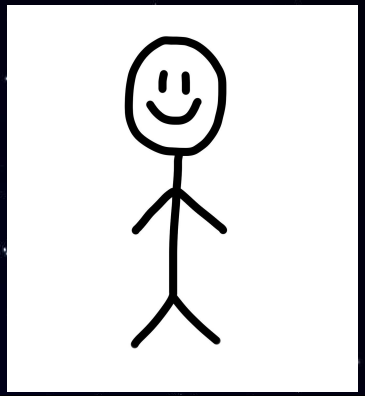
Group→ / ↓Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	* 72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	** 104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
				* 58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
				** 90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Explosion!!!



The Big Question:
What Powers this explosion?

But First - Why Does this Matter?



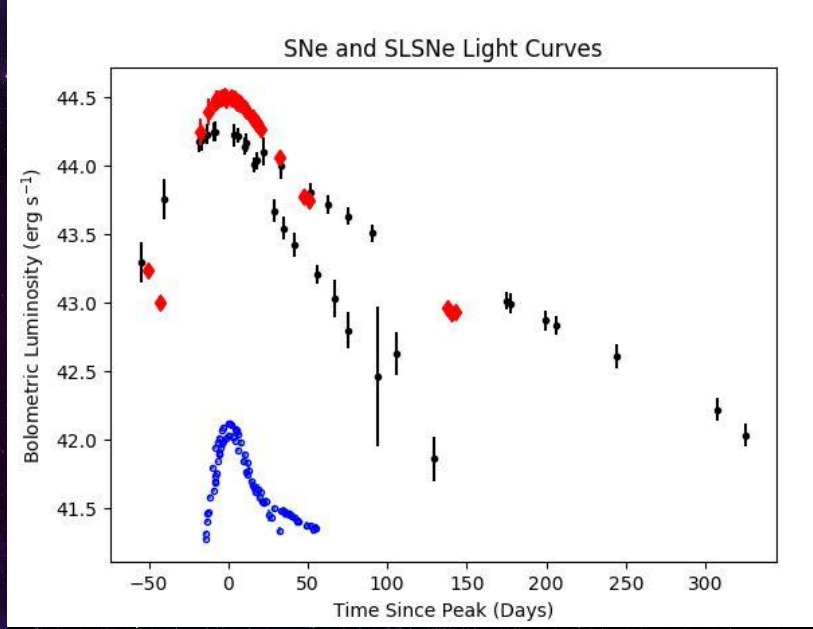
Brightness? Distance?

5.282×10^{25} erg

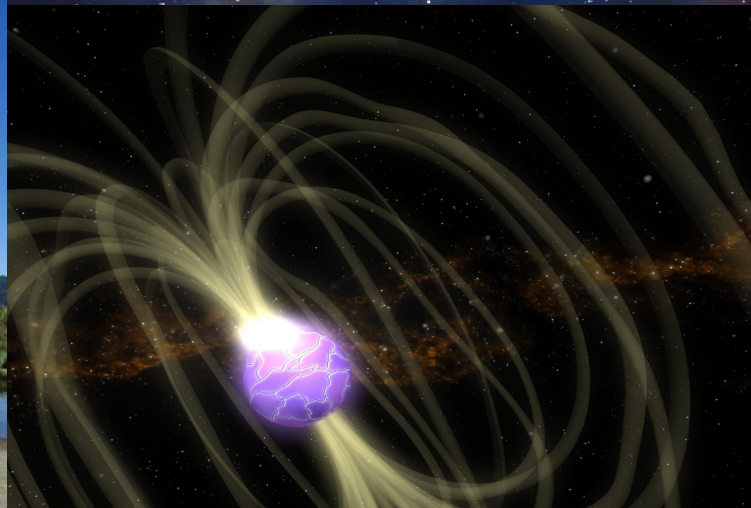
Total combined energy used by all homes in the U.S. in one year

0.000000000000000000000003%

Milky Way = 100,000 light years across

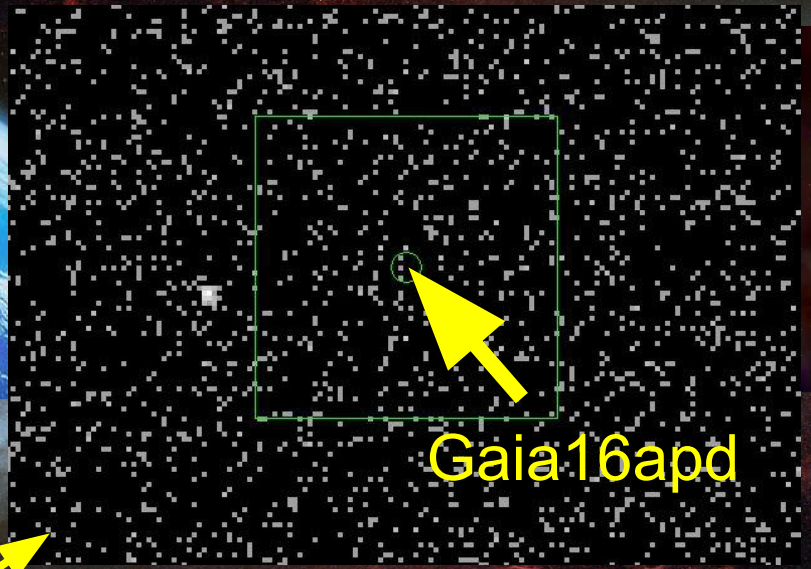


The Magnetar: The Best of the Three Models Explaining the Power Source



X-Ray Telescopes and Data

XMM Newton



X-Ray Photons
From Chandra

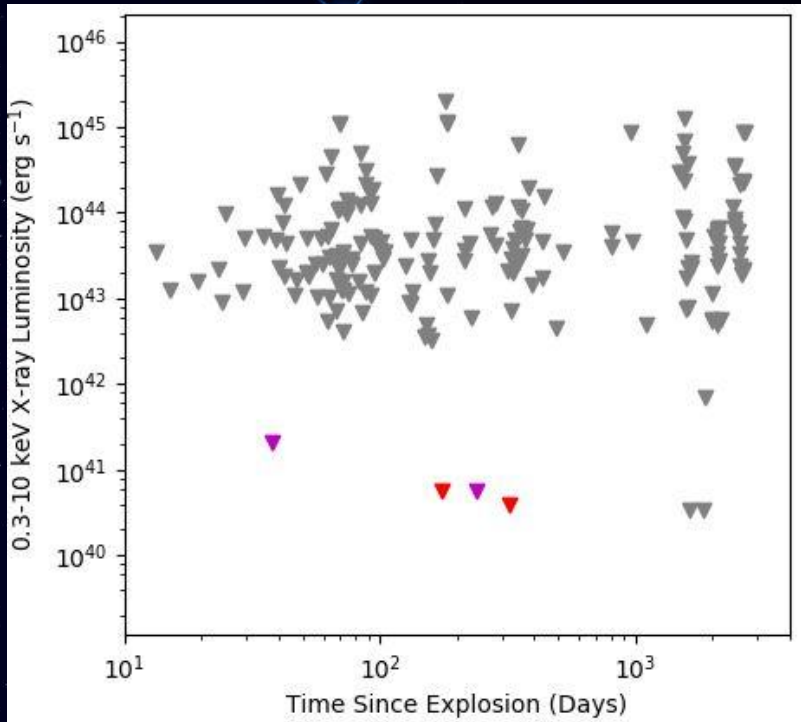
Chandra

We used 4 of these observations

Parameters for Jet Simulations

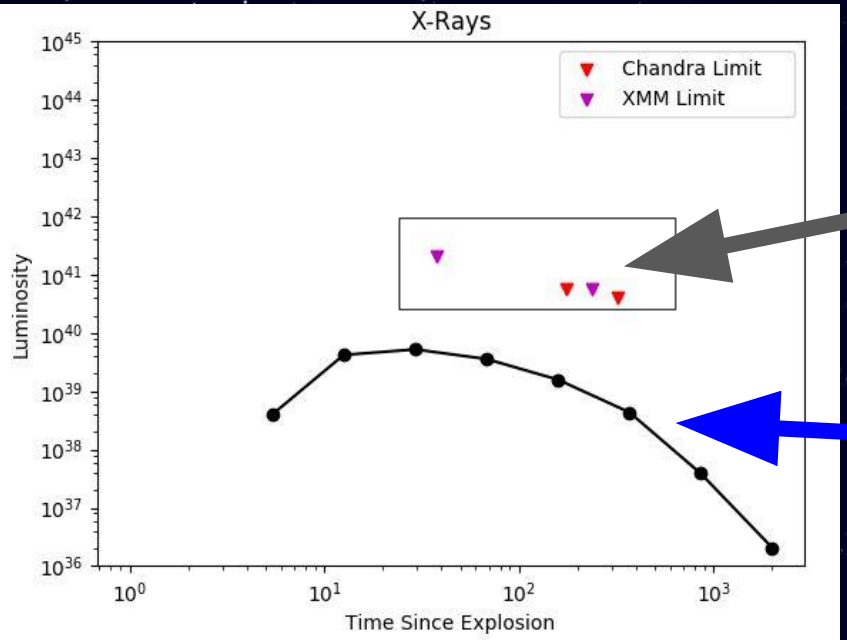
- Kinetic Energy
- Circumstellar Material Density
- Jet Opening Angle
- Observer Angle
- Epsilon E
- Epsilon B

X-Ray Limits



700+ Jet Simulations

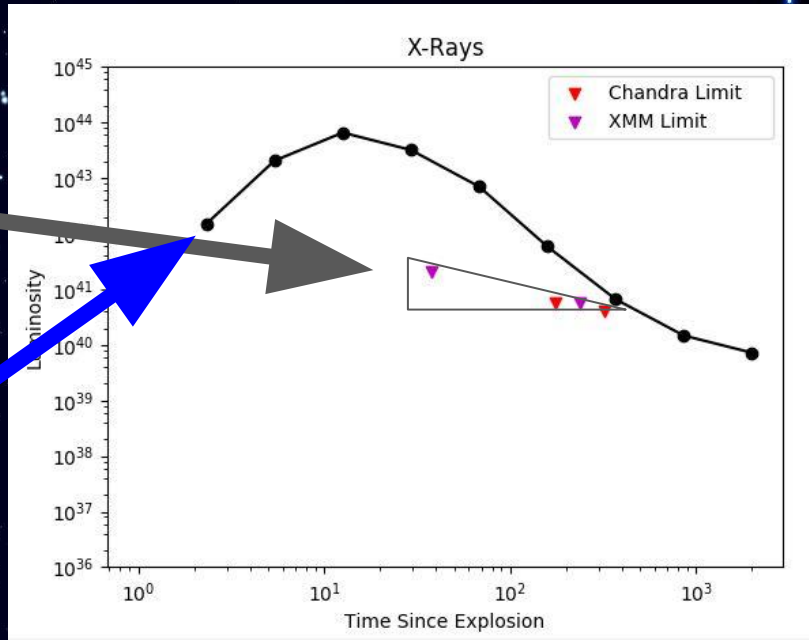
This Jet is plausible



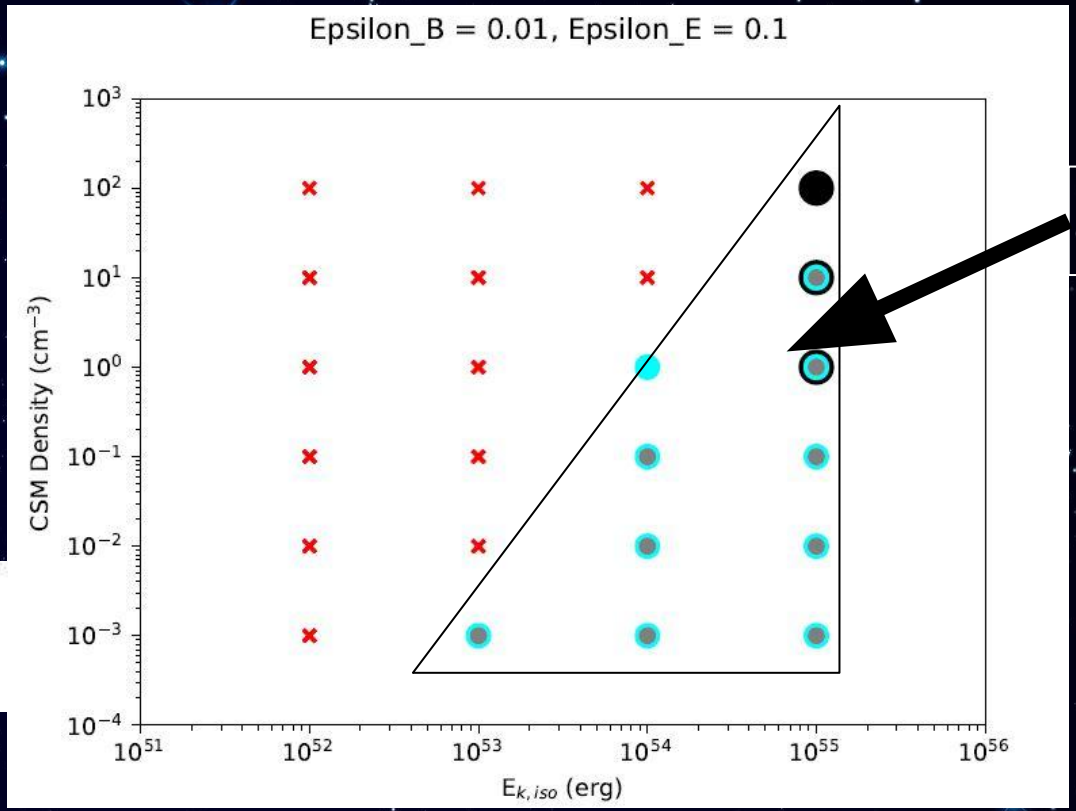
Data

Jet

This Jet is Ruled Out



What We Learned From This

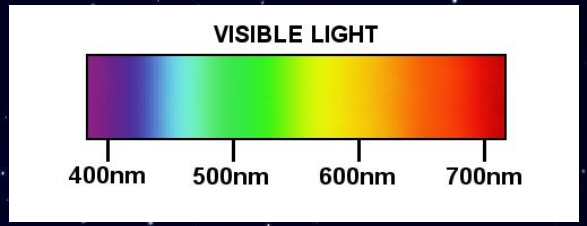


Obs Not Ruled out for Jet 5°, 10°, 15°
Jet = 5°, Obs = 30°
Jet = 5°, Obs = 7.5°
Jet = 5°, Obs = 10°

Conclusion

- Observations have ruled out environments with high kinetic energy
- This means that the most powerful jets are not behind the most energetic explosions

The Electromagnetic Spectrum



Gamma Ray X-Ray Ultraviolet Visible Infrared Microwave Radio Wave

Atom Radius

0.01 - 10 nm

Hair Width