

MICRO BLACK HOLES

NEUTRON STAR SAFETY ASSURANCE CONCERNS TO PARTICLE COLLIDER OPERATION OF TeV-SCALE P-P COLLISIONS

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Abstract

Astrophysical safety assurances in White Dwarf (WD) longevity and Neutron Star (NS) longevity were proposed in the 2008 safety report [1] commissioned at CERN regarding the existential risks to Earth from micro black holes (MBH) created in Proton-Proton (P-P) collisions at the Large Hadron Collider (LHC) in the event of hypothetical stable TeV-scale MBH. The WD safety assurance being stated as only applicable to MBH of dimensions $D \leq 8$ and at no greater than 14 TeV energy levels, the NS safety assurance was therefore provided as the solitary astrophysical safety assurance (other than Hawking Radiation theory) outside this remit.

Amid suggestion in outsider-debate [2][3][4] that the process of Hawking Radiation (HR) theorised on such TeV-scale MBH may prove less effective in practice than in its mathematical model, a closer look at the NS assurance is reasoned herein. This short paper presents concerns regarding the NS safety assurance as a solitary safety assurance for MBH of greater dimensions, and/or for MBH created at greater energy levels (> 14 TeV) than those which a solid WD safety assurance [3] can provide.

1. Introduction

The basis for the accepted NS safety assurance is that some cosmic-ray (CR) to surface collisions on such are analogous to P-P collisions in particle colliders, with NS capable of slowing/capturing MBH produced in such collisions. The continued NS existence is seen as evidence that such hypothetical stable MBH are not produced.

In considering such as a safety assurance, CR deflection was assessed in detail in the CERN safety report [1] due to the ultra-high magnetic field strengths associated with NS, and in doing so also considered both neutrino flux, and more elaborate scenarios of secondary MBH capture from production in binary pairs as alternatives.

Excluding the more elaborate circumstances of secondary MBH capture in binary pairs as over-elaborate, and assurances based on neutrino flux as based on unreliable data, only the hypothetical direct production of MBH on NS, from non-deflected CR impacts on the surface of NS, is reasoned here as a qualifiable safety assurance.

2. Magnetic Fields & Magnetic Deflection

Whereas an upper limit of a 100kG magnetic field strength for CR deflection was set as a criteria in determining safety assurance based on WD observation and measurement [3][1], such upper limits were not applied for the determination of safety assurance based on NS observation and measurement. Instead, as all known NS have far stronger magnetic fields, upwards from 10^8 G, a determination of maximum energy penetrable to a typical NS was determined (without any error tolerance values provided), for perpendicular impingement of NS with lowest known field strengths, giving collisions just above the LHC CM energy, with other impingements less effective.

Some consideration in the safety report was also given to CR penetration of theorised weaker magnetic fields at the polar regions of NS, though such assurances cannot be supported with verifiable astrophysical measurement. Indeed, the basic structure can be considered multipolar which would dampen weakness at any specific pole [5].

It is also noted that a number of discrepancies in the safety report, regarding the use of uncorrected production rate figures in conclusions on NS safety assurance, have been highlighted in an 'outsider' independent study [4], to the effect that magnetic fields of all known NS are too strong for significant MBH production from direct CR.

It is reasonable to surmise that NS safety assurance based on direct impact of CR is less reliable than assurance based on WD observation and measurement, where magnetic field strengths are far weaker, of the order 1,000:1.

3. Consideration for Sub-Millisecond Pulsars

Pulsars – rapidly rotating highly magnetised neutron stars – have provided accurate references in our Universe due to their regularity and predictability, to which there are now over 2,000 pulsars observed and measured [8].

Each of these pulsars have been measured to have a very distinct and consistent Barycentric period, of periods in a range from several seconds to just over 1 millisecond [8], with older pulsars typically having shorter periods.

When one generates a plot of pulsar periods relative to the estimated age of such pulsars (Figure 1), there is a noticeable cut-off at approximately 1.5 milliseconds. In Appendix 1, pulsars are listed in ascending order of Barycentric period, in which it can be seen that there are in fact very few pulsars below 2 milliseconds, and none below 1 millisecond - with the lowest known pulsar measured at just under 1.4 milliseconds (0.00139595482s).

It has been noted that most neutron star equations of state allow shorter periods [6], and it has been speculated that the lack of such pulsars with $P < 1.5$ ms is caused by gravitational wave emission from R-mode instabilities.

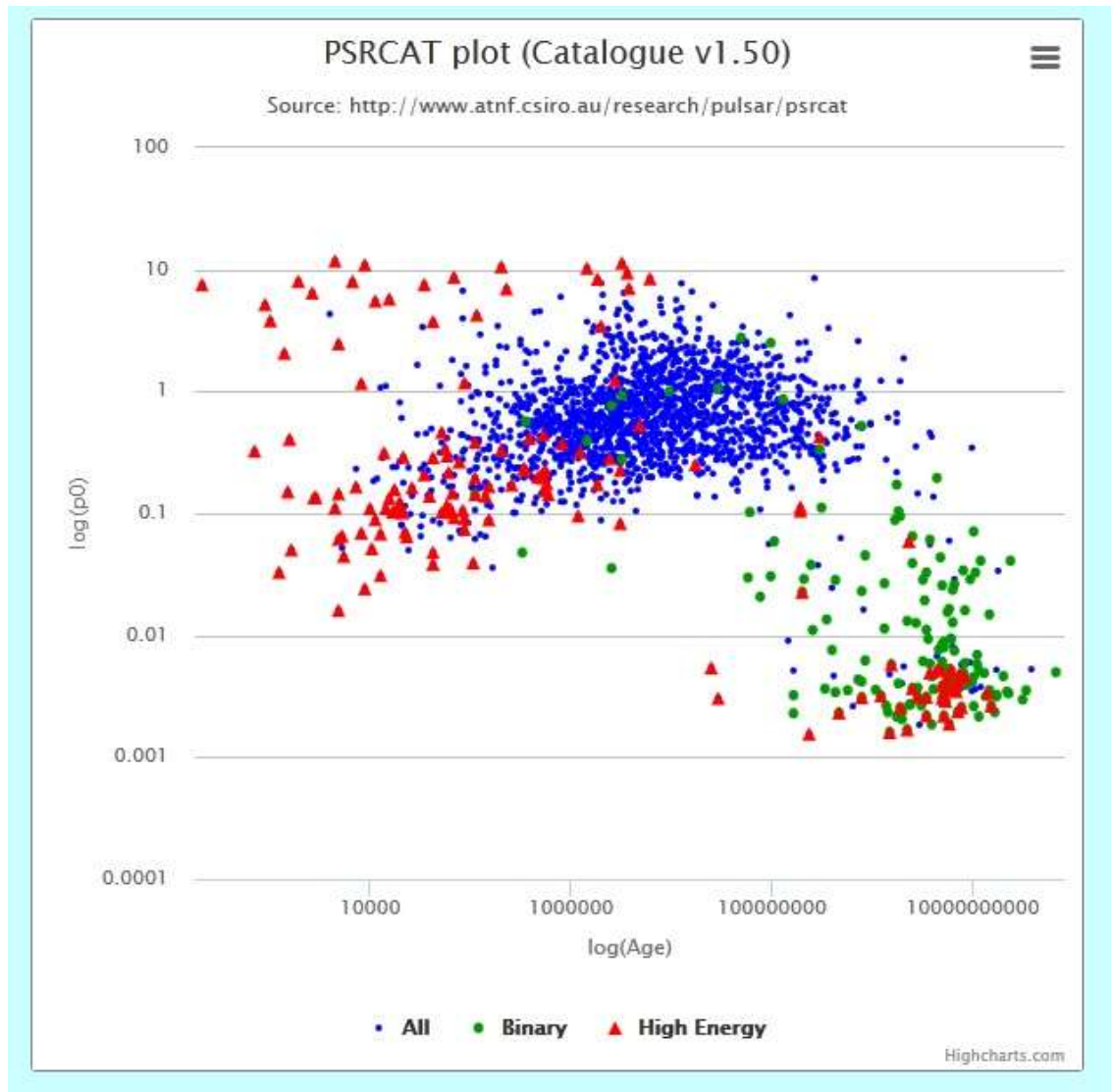


Figure 1: Generated plot of all known pulsars, illustrating Barycentric period (p_0) vs estimated Age. Note the distinct lack of pulsars with sub-millisecond p_0 periods.

However, if one considers the pulsar as a rotating magnetic dipole, then the surface magnetic field strength can be calculated [6] and can be derived relative to the Barycentric period, giving typical values of $10^{12} - 10^8$ G.

$$B \propto (P\dot{P})^{1/2}$$

As the existence of millisecond pulsars with 10^8 G fields were used as a safety assurance to LHC collisions, it is reasonable to consider the non-existence of sub-millisecond pulsars which would have fields lower than 10^8 .

In the context of such safety assurances, one should consider the non-existence of sub-millisecond pulsars being due to their lower magnetic fields allowing for more significant MBH production from direct CR collisions. In other words – a non-existence of sub-millisecond pulsars could be considered observational evidence of not only the production of stable MBH on NS with lower order magnetic field strengths, but NS destruction due to MBH.

4. Conclusions

In consideration of the NS safety assurance of P-P collisions concerning MBH of dimensions $D > 8$, and/or for MBH created at energy levels > 14 TeV, one finds that not only are there are various discrepancies in the safety assurance, but observational evidence that stable MBH can be created from comparable astrophysical processes.

In this circumstance, it should not only be deemed unsafe to conduct P-P collisions at energies > 14 TeV, but for the safety of P-P collisions at lower energy levels to be reconsidered in the context of MBH of dimensions $D > 8$.

This is in stark contrast to the position taken by the CERN commissioned safety report to LHC operations today.

ABBREVIATIONS & ACRONYMS:

ATNF	Australia Telescope National Facility
CERN	Organisation européenne pour la recherche nucléaire (European Organisation for Nuclear Research)
CM	Centre of Mass
CR	Cosmic Ray(s)
D	Dimension(s)
G	Gauss
HR	Hawking Radiation
LHC	Large Hadron Collider
MBH	Micro Black Hole
NS	Neutron Star
P	Barycentric Period
P-P	Proton-Proton (i.e. Proton-to-Proton Collisions)
TeV	Terra Electron-Volt
WD	White Dwarf

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- [7] Consideration for sub-millisecond pulsars – or the lack thereof . Kerwick. 2012. <http://lifeboat.com/blog/2012/05/consideration-for-sub-millisecond-pulsars-or-the-lack-thereof>
- [8] Australia Telescope National Facility Pulsar Catalogue 2014 <http://www.atnf.csiro.au/research/pulsar/psrcat/>

Appendix 1: List in ascending order of pulsars with shortest periods P0 (source: ATNF)

#	P0 (s)		P1_I
1	0.00139595482	6	hrs+06 *
2	0.001557806472448817	3	cbl+95 1.05e-19
3	0.00160740168480632	3	aft94 1.13e-20
4	0.00165	0	kcj+12 *
5	0.00166	0	hrm+11 *
6	0.00167663	0	rhs+05 *
7	0.00168798744440059	4	asr+09 1.02e-20
8	0.00172862	0	rhs+05 *
9	0.00174	0	kcj+12 *
10	0.00184	0	rap+12 *
11	0.0018456662924246	5	hfs+04 *
12	0.001855732795729	11	cls+13 *
13	0.0018771818845850	2	aaa+10b 5.36e-22
14	0.00204816	0	rhs+05 *
15	0.0020569603924157	6	nbb+14 1.59e-20
16	0.00207251	0	rhs+05 *
17	0.00210063354535247	3	fck+03 -1.06e-20
18	0.00214991236434921	5	fbw+11 1.78e-20
19	0.00215928839043292	5	brr+13 *
20	0.002166	1	hrs+07 *
21	0.0021866997715528	15	kjr+11 *
22	0.00219469577985001	7	nbb+14 9.59e-21
23	0.00219666	0	fre08 *
24	0.00219780	0	rhs+05 *
25	0.00224470	0	rhs+05 *
26	0.00229	0	hrm+11 *
27	0.0022947270806719	29	lfrj12 *
28	0.0023230904678309	17	hlk+04 7.60e-20
29	0.00233851444011854	4	nbb+14 2.07e-21
30	0.00234455954688568	11	nbb+14 2.45e-20
31	0.002352344	1	clf+00 *
32	0.00237987896026	4	gfc+12 4.13e-21
33	0.00238	0	rap+12 *
34	0.002389420757786	1	hrs+07 *
35	0.00241	0	hrm+11 *
36	0.00244	0	kcj+12 *
37	0.002451	0	fre08 *
38	0.00246259	0	fre08 *
39	0.002484	1	hrs+07 *
40	0.002487	1	hrs+07 *
41	0.002545	1	hrs+07 *
42	0.0025603710316720	3	pgf+12 *
43	0.0025731519721683	2	kcj+12 4.05e-21
44	0.0026056722466	1	lr11 *
45	0.00261	0	hrm+11 *

46	0.00262357935251098	14	fck+03	6.37e-20
47	0.0026303807397848	8	lfl+06	*
48	0.0026433432972417	3	fck+03	2.96e-20
49	0.0026521296710897	4	bgc+13	2.19e-21
50	0.00266059331683918	7	nbb+14	*
51	0.0026779231971205	2	blr+13	-1.20e-19
52	0.0027191120623197	3	bbb+13	*
53	0.00272	0	rap+12	*
54	0.00273	0	rap+12	*
55	0.00273258863244	9	rsa+14	*
56	0.002812	0	rhs+05	*
57	0.0028304059578772	5	fck+03	*
58	0.002896215815562	2	cgj+11	*
59	0.0029471080681076401	9	vbc+09	1.61e-21
60	0.00296	0	hrm+11	*
61	0.00296965	0	rhs+05	*
62	0.0029778192947556	5	wdk+00	-1.54e-21
63	0.002988	1	hrs+07	*
64	0.00299926	0	fre08	*
65	0.003020060260978	59	lfrj12	*
66	0.00305	0	hrm+11	*
67	0.0030539543462594	4	fck+03	-2.33e-20
68	0.003054315552978	6	vbc+09	1.62e-18
69	0.003059448798020229	30	lfrj12	*
70	0.00306184408653189	4	vbc+09	8.82e-21
71	0.00308	0	rap+12	*
72	0.0030842332007	2	rsm+13	*
73	0.00310221391893416	16	nbb+14	5.85e-20
74	0.003118	1	hrs+07	*
75	0.003119226579079	4	rrc+11	*
76	0.003148669579439	9	rrc+11	*
77	0.0031508076534271	6	dpr+10	-3.87e-21
78	0.00316	0	hrm+11	*
79	0.00316331581791380	2	llww05	1.63e-21
80	0.003170139227806	2	bck+13	*
81	0.003182	1	hrs+07	*
82	0.00319294082	1	hrs+07	*
83	0.0032	0	ksr+12	*
84	0.00321	0	rap+12	*
85	0.0032103407093484	5	fck+03	-3.05e-21
86	0.003232273969155	4	lrfs11	*
87	0.0032337373331158	65	lfrj12	*
88	0.00326618657079054	9	cbp+12	2.05e-21
89	0.00328914	0	fre08	*
90	0.00329	0	hrm+11	*
91	0.00330434	0	fre08	*
92	0.00332	0	rap+12	*
93	0.0033543360829062	1	lrfs11	*
94	0.00339270965933	4	kjr+11	*
95	0.0034177704450548	17	lfrj12	*

96	0.0034452510710225	2	cnt96	1.51e-21
97	0.00347877078318731	3	nss+05	7.66e-21
98	0.003480463	1	clf+00	*
99	0.0034849920616611	5	fck+03	-4.72e-20
100	0.00349663378270016	19	jsb+10	2.90e-21
101	0.003528072	5	and92	*
102	0.00353632915276031	13	fck+03	9.69e-20
103	0.003539375658423	3	lfl+06	*
104	0.003543431438847	1	jbo+07	*
105	0.003559763768043	6	csl+12	*
106	0.00356957	0	rhs+05	*
107	0.00357528861884712	12	bbb+13	*
108	0.00359	0	kcj+12	*
109	0.0035938521270515	34	lfrj12	*
110	0.00359792850865547	3	vbc+09	8.42e-21
111	0.00360	0	rap+12	*
112	0.0036	0	dsm+13	*
113	0.003617993078111	7	csl+12	*
114	0.003618524251059	2	fhn+05	*
115	0.0036250966601209	18	lfl+06	-4.09e-21
116	0.0036257455713977	5	tsb+99	6.25e-21
117	0.00363	0	rap+12	*
118	0.003643021	1	clf+00	*
119	0.00365032889720	1	dpm+01	*
120	0.00365859	0	fre08	*
121	0.0036766432175977	10	fck+03	*
122	0.003683878711077	3	rrc+11	-2.11e-20
123	0.00372	0	mlb+12	*
124	0.003722	1	hrs+07	*
125	0.00372634848296641	5	vbc+09	2.02e-20
126	0.00373869966067	2	lrfs11	*
127	0.0037471544	6	jbo+07	*
128	0.00377	0	hrm+11	*
129	0.0037844047882356	3	gsf+11	4.08e-21
130	0.0037851238	4	kek+13	*
131	0.00378815551961303	52	lbr+13	4.04e-21
132	0.003793629114948	3	frb+08	*
133	0.0038613247042986	6	bjd+06	3.36e-21
134	0.003889	0	drr11	*
135	0.0039148731963690	6	sfl+05	*
136	0.003931852642	2	pfb+13	*
137	0.00393452408033124	11	nss01	2.56e-21
138	0.00402704270710	15	and92	*
139	0.0040331811845700	5	fck+03	*
140	0.004039	0	fre08	*
141	0.0040403791435629	4	fck+03	-4.34e-20
142	0.004074545940854022	9	vbc+09	7.10e-21
143	0.00409179738145616	3	gsf+11	8.53e-21
144	0.0041	0	dsm+13	*
145	0.004100	0	fre08	*
146	0.0041105439567658	12	bbb+13	*

147	0.004159	0	fre08	*
148	0.0041750173128551	8	blr+13	*
149	0.004185543936664	3	csl+12	*
150	0.00418617720284089	25	lfrj12	*
151	0.004200101791882	7	lcm13	*
152	0.00420518	0	rhs+05	*
153	0.004226532003547	3	lrfs11	*
154	0.00423	0	rap+12	*
155	0.00429	0	rap+12	*
156	0.00430	1	fsk+04	*
157	0.0043428266963896	4	fck+03	9.33e-20
158	0.0043461679994601	14	fck+03	*
159	0.00439	0	rap+12	*
160	0.004394	0	fre08	*
161	0.004397	0	fre08	*
162	0.00444803	0	fre08	*
163	0.004461	0	fre08	*
164	0.0045051589484591	7	nbb+14	1.02e-20
165	0.0045086417449716	2	dlk+01	1.23e-20
166	0.004553527919736	4	bbb+13	*
167	0.004554	0	fre08	*
168	0.004570136525082782	7	sns+05	8.07e-21
169	0.004571765939750	2	cpl+06	*
170	0.00462164151699818	15	vbc+09	1.82e-20
171	0.0046259624652639	15	lfl+06	*
172	0.004629	0	fre08	*
173	0.0046311962778409	2	lwf+04	1.48e-21
174	0.00465143521539	13	and92	*
175	0.00471398	0	rhs+05	*
176	0.004771	0	fre08	*
177	0.004791822704	3	mlb+12	*
178	0.0048028043457	3	and92	*
179	0.0048084282098381	4	nt95	4.11e-21
180	0.004810	1	clf+00	*
181	0.00484	0	rap+12	*
182	0.004850	0	fre08	*
183	0.0048654532073692	3	aaa+09e	1.01e-20
184	0.0048727658629793	17	dfc+12	8.11e-21
185	0.004888	1	hrs+07	*
186	0.004909239016418	5	csl+12	*
187	0.00492589	0	rhs+05	*
188	0.00493111494073988	5	vbc+09	1.07e-20
189	0.00496515	0	fre08	*
190	0.00498358394056511	3	gsf+11	8.44e-21
191	0.004990575114114	3	frg07	*
192	0.00502854	0	rhs+05	*
193	0.00507	0	rap+12	*
194	0.00508691	0	fre08	*
195	0.005116387644239	12	eklk13	*
196	0.00511971	0	fre08	*
197	0.005139936774902	4	frb+08	*

198	0.005162204637121	4	vbc+09	-3.41e-21
199	0.0051852019041260	3	clm+05	9.58e-21
200	0.005192324646411	7	cgj+11	*
201	0.005223271015190	1	jbo+07	*
202	0.0052415662037958	29	lfrj12	*
203	0.00525574901411968	12	lcw+01	1.14e-20
204	0.0052773269323093	15	cpl+06	-3.07e-23
205	0.00531255028907845	9	vbc+09	*
206	0.00535757328486266	18	fck+03	-4.48e-21
207	0.005362	0	vbc+09	1.74e-20
208	0.005384325706188	9	fhn+05	*
209	0.00542	0	fre08	*
210	0.0054400041632727	31	lfrj12	*
211	0.00544297516	6	hrs+07	*
212	0.005471	1	fsk+04	*
213	0.00549096850013900	13	vbc+09	8.74e-21
214	0.00554014	0	rhs+05	*
215	0.00555	0	rb13	*
216	0.005553592524205	2	awkp97	*
217	0.00575677999551320	17	fck+03	-5.20e-20
218	0.005757451924362137	99	vbw+08	1.37e-20
219	0.00578804	0	fre08	*
220	0.0057901517700238	5	nbb+14	5.17e-21
221	0.0057923027349664	4	lmcs07	1.09e-20
222	0.005840	0	fre08	*
223	0.00585	0	rap+12	*
224	0.0058500957646929	6	jac04a	2.28e-20
225	0.005909	0	fre08	*
226	0.0059489575348502	6	spl04	8.02e-21
227	0.0060006034432179	19	eb01b	*
228	0.006074542086503	6	frb+08	*
229	0.00611664	0	rhs+05	*
230	0.0061331665102401	8	gsf+11	2.83e-20
231	0.00621853194840048	3	kw03	3.05e-20
232	0.006226932720487	3	frb+08	*
233	0.006284	1	fsk+04	*
234	0.006547	0	fre08	*
235	0.0067433942397	3	and92	*
236	0.006907549392921	3	bbb+13	*
237	0.00708491	0	rhs+05	*
238	0.00709	0	hrm+11	*
239	0.007101	0	dpm+01a	*
240	0.0071756146066706	8	lrfs11	*
241	0.007453584373467	3	nbb+14	-1.71e-20
242	0.00747422422621133	12	vbc+09	1.74e-20
243	0.007588479807364	5	fck+03	*
244	0.0076128487111379	68	lfrj12	*
245	0.00762	0	hrm+11	*
246	0.00764587288390884	4	jsb+10	2.35e-20
247	0.00780	0	mlb+12	*
248	0.007946940657879	21	awkp97	*

249	0.007987204796261	4	h1k+04	1.57e-20
250	0.00812279804398456	14	vbc+09	*
251	0.008357798500844	2	cpl+06	*
252	0.0084360953044	1	lmbm00	*
253	0.00848628211574	6	nbb+14	*
254	0.00866690	0	rhs+05	*
255	0.008869961227277	4	eb01b	*
256	0.009035285247765	4	cpl+06	*
257	0.009343030685703	7	h1k+04	*
258	0.009347972210248	7	clm+01	*
259	0.009423406717798	17	nbb+14	1.24e-20
260	0.00957019	0	rhs+05	*
261	0.00968	0	mlb+12	*
262	0.009684273	2	kek+13	*
263	0.0099	0	dsm+13	*