The Application of Astronomical Observation to LHC/Collider Safety

TECHNICAL NOTE

Environmental Safety Assessment

TECNHICAL NOTE: THE APPLICATION OF ASTRONOMICAL OBSERVATION TO LHC/COLLIDER SAFETY

Regarding a minor safety concern raised in the 2012 whitepaper (published here on Sept 3rd 2012) -

Micro black holes - Discussions on the Hypothesis that Cosmic Ray Exposure on Sirius B Negates Terrestrial MBH Concerns from Colliders.

"In order for the white dwarf analysis by G&M [3] to be considered a viable safety assurance to LHC collision experiments, the accuracy of the magnetic field strengths to within the range applied to such stars used for safety assurances in the LSAG 2008 safety report should be within the standard industrial safety tolerances, though the examples sampled [18] concluded a mere 99% confidence - L745 - 46A (WD0738-172) at 7 kG with 99% confidence interval of ±6 kG, and GD 40 (WD03 00-013) with an upper limit of 12 kG with 99% confidence. A return to such spectroscopic and polarimetric surveys should determine confidence to industrial safety standards with an upper limit of 100 kG [3], over which significant magnetic screening occurs, for such safety assurance."

The following response from the LHC Safety Assessment Group (LSAG) details why this issue raised is not a safety concern due to improved measurement of such magnetic fields in more recent literature

--------------------------- START OF EXTRACT ------------------------------

On the issue of WD magnetic fields and the reliability of their determination. We surveyed the recent literature, where there is significant progress, since the B field measurement technology and the surveys have greatly improved since the Mangano and Giddings paper.

Take a look, for example, at a couple of papers:

http://arXiv.org/pdf/1206.5113.pdf

http://arxiv.org/pdf/1208.3650.pdf

These papers document most extended lists of WDs with fields measured in the 1-100 kG range. Many of these measurements are not just limits, but actual measurements, with uncertainty ranges. Even taking these 1-sigma uncertainties at the 3or 5 sigma level, leads to B fields well below the 100kG threshold. A large fraction of these WDs have masses above 0.6 solar masses, thus in a safe range as far as stopping is concerned. But a few are heavier. For example, WD2359-434, with M = 0.98Msun and T ~ 1.5 Gyr (which was listed in G&M2008), has now a confirmed field in the range of 3-4kG. (see Section 4.1 of Landstreet et al, the 2nd ref above). Other WDs with masses over 0.75Msun (which means log(g)~8.2) are also listed with fields in the few kG range (see e.g. WD21050-820 in table 2 of Landstreet et al). Notice also that at least another of the WDs listed in M&G2008 had a positive B measurement, and not just a limit, namely WD2246+223.

------------------------------ END OF EXTRACT -----------------------------

The full content of the response from the LSAG is included herein as Appendix 1, a formalisation of which would underwrite LHC p-p collisions based on astronomical observations – a safety assurance that is wholly independent of the unproven (and occasionally disputed) theory of Hawking Radiation.

Appendix 2 outlines argument against the validity and/or effectiveness of Hawking Radiation theory.

It is also noted that the LSAG 2008 safety report also contains a second safety assurance based on astronomical observation – based on the longevity of neutron stars. To date few have challenged this second safety assurance, and whilst one could suggest the lack of sub-millisecond pulsars in the observable universe [6] is due to MBH capture & growth (sub-millisecond pulsars would have lower magnetic fields), such hypotheses are at present mere speculative conjecture. The basis for any such argument would require very specific consideration of the magnetic field strengths in question here.

Most significant of such critical analyses are those published at the self-styled LHCSafetyReview.org, where draft documentation [8] discusses potential weaknesses in various safety assurances.

The LSAG 2008 safety report derives a 10^8 G field strength as the approximate cut-off point where MBH are likely to be captured by neutron stars, and specific examples are selected for a safety assurance, though more typical values for observed neutron stars calculate far higher values of 10^12 G. Taking it further, if one applies the same 100kG threshold over which it is agreed significant magnetic screening occurs in white dwarf stars, and considering that neutron stars have a far smaller target area from which to deflect cosmic rays from by such magnetic screening, one would have difficulty in finding similar confidence in safety assurance without considering neutrino flux as an alternative. It is for such reasons that the NS safety assurance is not argued as the reliable assurance.

As cited in Appendix 1, reviewing certain recent literature, including a study of high proper-motion white dwarfs, spectropolarimetry of a cool hydrogen-rich sample (Kawka, Vennes, 2012) and on the incidence of weak magnetic fields in DA white dwarfs (Landstreet, Bagnulo et al, 2012), one can find these contain extended lists of white dwarfs with fields measured within the 1-100 kG range, many of which have measurements and uncertainty ranges leading to B-fields below the 100 kG threshold.

However – the WD safety assurance is only valid for lower orders of dimensions of MBH [5], and column densities required to stop the heaviest black holes (D>=8) exceed the stopping power of WD.

To cover scenarios of MBH with D>=8, further analysis is required on the NS safety assurances [5][8].

APPENDIX 1: FULL TEXT OF LSAG RESPONSE

----- Forwarded Message -----
From: "lsag" <LHCSafetyAssessment.Group@cern.ch>
To: "Tom Kerwick" <tom.kerwick@ireland.com>
Cc: "lsag" <lsag@cern.ch>
Sent: Monday, 22 October, 2012 15:13:57 GMT +00:00 GMT Britain, Ireland, Portugal
Subject: Re: magnetic fields & white dwarfs

dear Dr Kerwick, apologies for this long time to reply, but we wanted to be able to take a closer look at these issues, and at the discussion between you and roessler, included in your paper.
We will not comment on the latter, since this appears biased by some basic misunderstanding of what is known and solid, and of what is a plain conjecture.

On the issue of WD magnetic fields and the reliability of their determination. We surveyed the recent literature, where there is significant progress, since the B field measurement technology and the surveys have greatly improved since the Mangano and Giddings paper.
Take a look, for example, at a couple of papers:
http://arXiv.org/pdf/1206.5113.pdf
http://arxiv.org/pdf/1208.3650.pdf
These papers document most extended lists of WDs with fields measured in the 1-100 kG range. Many of these measurents are not just limits, but actual measurements, with uncertainty ranges. Even taking these 1-sigma uncertainties at the 3or 5 sigma level, leads to B fields well below the 100kG threshold.
A large fraction of these WDs have masses above 0.6 solar masses, thus in a safe range as far as stopping is concerned. But a few are heavier. For example, WD2359-434, with M = 0.98Msun and T ~ 1.5 Gyr (which was listed in G&M2008), has now a confirmed field in the range of 3-4kG.
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Notice also that at least another of the WDs listed in M&G2008 had a positive B measurement, and not just a limit, namely WD2246+223.

best regards,
LSAG,
LHC Safety Assessment Group

APPENDIX 2: HAWKING RADIATION AS A SAFETY ASSURANCE

Hawking Radiation (HR) is considered to result from the separation of particle & anti-particle pairs close to the event horizon of a black hole (BH) from the vacuum energy, where the anti-particle gets trapped inside the event horizon, but the particle escapes - effectively reducing the net mass of the BH, and by such process the BH evaporates – a process considered rapid at micro-BH sizes.

Several counter-arguments (largely considered as naive) to HR circulate in outsider-debate to LHC/Collider safety. Herein we consider two such arguments, expressed in the simplest of terms:

1. Of such particle-antiparticle pairs, it is reasonable to consider there an equal proportion of the in-falling member of the pair as the particle, and the escaped one the anti-particle - in which case in-falling particles can cancel in-falling anti-particles by a process of annihilation – e.g. electron–positron annihilation resulting in the creation of gamma ray photons (any of which are not then radiated would therefore increase the BH energy – not reduce it). However, for such argument to be relevant, energy for pair production must be sourced from the BH locality – as in from vacuum fluctuation of vacuum energy – not from just the BH gravitational energy (as in accepted theory), such that overall the BH could gain energy from its locality by HR – not deplete such from within.

2. The 'escaped' particles, and 'escaped' antiparticles of such pair production would require to be travelling at near luminal speed (escape velocity) away from the BH in order to fully escape the BH, and so one might expect only photons emitted at near-perpendicular to the BH event horizon. Furthermore - one could argue that radiated energy (i.e. red-shifted gamma ray photons) could accelerate accretion under a force similar to the attractive force of black body radiation [7] though the relevance that such could play on overall figures is considered here to be of negligible impact.

Of other's claims, when one considers gravitational time dilation – an effect that was predicted by Albert Einstein in his theory of relativity, and since confirmed by tests on general relativity – event horizon related phenomena such theorised as HR may not manifest in finite outside observer time.

For example, outside a non-rotating sphere, due to gravitational time dilation local time is defined:

$$\boldsymbol{t0 = tf\sqrt{(1 - r0/r)}}$$

-where ***t0*** is proper time, ***tf*** coordinate time, **r** distance from a BH with **r0** as the Schwarzchild radius.

Therefore as particles approach the event horizon (Schwarzchild radius) of a BH, i.e. ***r*** approaches ***r0***, the value ***t0*** approaches zero for any finite value of ***tf***. Therefore events at an event horizon cannot occur in finite time to an outside observer, with events close to same horizon significantly stretched.

It is also noted that Mathematician Georg Cantor found that infinity comes in different levels or alephs. This means the event horizon may not be as sharp as science believes it to be. In other words, escaping particles may have to pass through several sub horizons, which makes it less likely.

In this manner gravitational time dilation could severely dampen effects such as Hawking Radiation, though at the plank scale applicable to MBH, quantum effects can breach over the required distance. In fact, such gravitational time dilation effects are already incorporated in Hawking Radiation theory.

FURTHER READING / REFERENCES

[1] Discussions on the Hypothesis that Cosmic Ray Exposure on Sirius B Negates Terrestrial MBH Concerns from Colliders (Kerwick, 2012) http://vixra.org/abs/1208.0005

[2] A study of high proper-motion white dwarfs – I. Spectropolarimetry of a cool hydrogen-rich sample (Kawka, Vennes, 2012) http://arXiv.org/pdf/1206.5113.pdf

[3] On the incidence of weak magnetic fields in DA white dwarfs (Landstreet, Bagnulo et al, 2012) http://arxiv.org/pdf/1208.3650.pdf

[4] Black hole state evolution and Hawking radiation (D. Ahn, 2010) http://arxiv.org/pdf/1006.2198v3.pdf

[5] Astrophysical implications of hypothetical stable TeV-scale black hole (Giddings,Mangano,2008) http://arxiv.org/abs/0806.3381

[6] 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

[7] Attractive Optical Forces from Blackbody Radiation (Sonnleitner, Ritsche-Marte, Ritsch, 2013) http://prl.aps.org/abstract/PRL/v111/i2/e023601

[8] Black Hole Production at the LHC: A review of the Risks - Draft (Rev 0.03) (A. Rahman, 2010) http://www.lhcsafetyreview.org/docs/black-hole-review.pdf