

**MODEL NUMBER 7
OF A
“PUBLIC AWARENESS ANALYZED EXAMPLE”**

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WHERE: This is on p. 19 of **Review of the Safety of LHC Collisions** by J. Ellis, G. Giudice, M. Mangano, I. Tkachev, and U. Wiedermann, published as CERN (*Centre Européenne pour la Recherche Nucléaire* = *European Organization for Nuclear Research*) Theory Group Research Report CERN-PH-TH/2008-136 in 2008. It can also be found online at

<http://arxiv.org/abs/0806.3414> .

WHAT: This is a quote from a paper discussing physics research:

Our conservative estimate for the thermal production of a normal $A = 10$ nucleus at the LHC was 3×10^{-25} times the rate of nucleon production. Taking the latter rate to lie in the hundreds, we arrive at a probability of 10^{-13} that a single normal nucleus of size $A = 10$ is produced during the entire LHC program as a result of the essentially thermal dynamics in a heavy ion collision. So, if LHC would run for the entire lifetime of the Universe, the probability of producing such a single nucleus via thermal production would be $1/1000^1$.

Behind all the technical jargon, this paper is trying to estimate the probability that the Large Hadron Collider (LHC), a particle accelerator in Switzerland which was recently turned on, will produce some exotic bit of physics like a strangelet (a kind of strange subatomic particle which is quite massive but interacts only very little – but in nasty ways – with normal matter) or a microscopic black hole... which would destroy the entire world. One such “failure mode” (destroying the planet being considered a failure) of the LHC would be the production of one of these “ $A = 10$ ” nuclei, and this paragraph tries to put together an estimate of the probability of such an event, and then give an interpretation of this computed probability in order to show what a number of that (extremely small) size signifies.

ANALYSIS: The **probabilities** of various **events** – mostly, of producing one of these dangerous particles whose existences (and mechanics of creation) are conjectured by some theories of subatomic physics – are estimated and combined. In particular, it is estimated that the production would occur at a certain rate when the LHC is in operation. Clearly, then, the paper assumes that separate such events are independent, and it combines them by the simple probabilistic combination formula. In particular, a number is given for the combined probability of one such event happening if the production were to happen at the conjectured rate and if the LHC were to operate for the entire life of the Universe.

CRITICISM: What is suspicious about this result is how specific it is. Apparently, some theory predicts a certain rate of these dangerous particles – but this theory is under intense investigation, that is what the LHC was built for (at the cost of several billion dollars!). So this original probability estimate is quite suspect. Next, the assumptions underlying the combination of probability used are not made explicit nor are they well-justified. To top it off, an estimate for the age of the Universe is put into the formula, but this number varies by quite a bit in the scientific literature, so the specific result depending upon it is again very suspect.

In short: **Garbage In, Garbage Out.** Without making clear all its assumptions and giving estimated ranges for possible errors at all steps in the calculations, a result as specific as this one cannot be trusted much at all. A much better thing to do would have been to compare this to some other process or physical system where our lack of knowledge would not effect the outcomes. [*E.g.*, cosmic rays prove the LHC is safe! Google it if you’re worried.]