Compact Ultradense Matter Impactors

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Published March 15th, 2013

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"It all started while I was attending a lecture regarding the hotspot in Hawaii" Said lead author Dr. Johann Rafelski in an interview regarding his paper on Compact Ultradense Objects (CUDO's). There are numerous areas around the world where we see hotspots and they are still mysteries to many Geologists and Physicists as Dr. Rafelski states, "Somehow there is a conduit through the Earth's mantle emitting heat from far below but no damage to the Earth's crust…literally nobody knows how this came to be". There are only hypotheses as to their existence, thus making these hotspots a very hot topic. This led Johann Rafelski, Lance Labun, and Jeremiah Birrel to consider one such classification of impactors, CUDO's.

They began their paper with a question. "What if there are "dark" matter meteor and asteroidlike bodies in the Universe? Could some of them have collided with Solar System bodies and Earth?" Firstly it is important to understand what "dark" matter actually is. Dark matter is a type of matter hypothesized to account for much of the mass in the universe. It cannot be seen directly with telescopes, thus it does not emit nor absorb light or electromagnetic radiation.[3] So how does one know they exist? Its existence is inferred from its gravitational effects on visible matter with which it interacts.[3]

This leads to the proposed existence of CUDO's, in which you have a high density of matter in a small geometric cross section resulting in high surface gravity (i.e. "dark" matter asteroidlike bodies). In their paper they explain that such objects are likely to survive transit through Earth's atmosphere and therefore come in contact with Earth. A CUDO's high density of gravitating matter interacts very differently with solid rocky bodies than two solid bodies would. They explain that it is likely that the CUDO will practically always enter the target body (i.e. Earth) and exit the body with only a fraction of the kinetic energy damaging the solid bodies surface (i.e. the CUDO "punctures" the solid body) so they refer to these collisions with Solar System rocky bodies as "punctures". This is the basis for their paper, and the reason for their hypothesis that possibly these hotspots (holes in the Earth's mantle) could be caused by collisions with CUDO's.

They began their paper by considering first the origin of these CUDO's. Then they looked at the rate of collisions (punctures) and the lifetimes of these masses to see if they could in fact be a reasonable answer to this question of hotspots. One potential source of CUDO's is from collisions of neutron star cores that contain strange quark matter. The CUDO meteors can be produced as fragments from these

collisions producing macroscopic collections of this dark matter.[1]

The paper then goes on to discuss, in greater detail, the CUDO punctures and CUDO stability on impact. In their conclusion they discuss that "for a small energy loss distributed across the puncture conduit (hole) even relatively massive CUDO punctures preserve the integrity of the target (i.e Earth) and inflict in such event a relatively small shotlike damage."[1]

They also included in their discussion that there are three characteristic CUDO features in comparison to normal matter impactors. Firstly, before the impact occurs, the CUDO core binds and stabilizes meteorite material, making the impactor appear exceptionally stable. Secondly, during the impact on the surface, the normal matter material will largely evaporate or be swept away with the CUDO into the mantle of the Earth. This proposes that a possible signature of CUDO surface impacts to be the absence of both the CUDO and normal impactor material after the impact. Lastly, at exit, the kinetic energy of the moving CUDO through the opposite side of the target may create an exit "hump" and/or appearance of lava flow in environments where none should be present. While the rapid terrestrial surface evolution of Earth would mask some exit features, they should be well preserved on Mars, the Moon, and other rocky bodies.[1]

Existing models for meteor impacts do not presently allow for the possibility to model a high density impactor. The absence of this type of detailed impactor model allows for this great uncertainty of whether or not these hotspots exist due to impacts or eruptions. The long term impacts of this research should provide a path to recognizing the presence of asteroid CUDOs in the Universe, and thus offer new insights about novel forms of ultrahigh density matter.[2]

So although this paper may not be the be-all and end-all argument for CUDO's existence, it is however a good starting point and warrants further research and investigation into the possibility of this class of impactors being the cause of Earth's numerous hotspots.

References:

[1] Johann R., Lance L., Jeremiah B., **Compact Ultradense Matter Impactors**, Physical Review PRL 110.111102 (2013), March 15th

[2] Johann R., Christopher D., Lance L., **Compact Ultradense Objects in the Solar System,** Earth and Planetary Astrophysics arXiv:1303.4506v1 [astro-ph.EP], 2012, December 12th

[3] http://en.wikipedia.org/wiki/Dark_matter

Interview Questions

Q. What field do you have your PhD in?

A. I have a PhD in Theoretical Physics and this is what I do most of the time but also have a general interest in interpretive data which is where my strength

is. So most of my time I look at results of things that are known but not fully understood and I try to find an understanding. I have done this for almost 40 years so it focuses me well for this type of work which you have picked up.

Q. What was the motivation that got you interested in this topic and got you started on the research for this paper?

A. It is a very interesting case but was actually a very simple event. At some point in my career I had run into a lecture given by a geologist on Hawaii, and he explained that the island is one single hole, so to, speak in the mantle and the crust moves over the hole (like a volcano). Then the lecturer said something that turned me towards this question, he said that it is not known how this particular Hawaii hotspot (a hole in the mantle of the Earth) got there. Somehow there is a conduit through the mantle emitting heat from far below but no damage to the Earth's crust. He said literally nobody knows how this came to be. So I looked up hotspots on earth and Hawaii is not unique there are maybe 30 or 40, none of which are really understood. So because of my research I came to the idea that maybe we have had an impact on Earth. I then came across a few papers which pointed out that when a collision occurs with earth, it never punctures the surface (break through), the crust remains intact and there are many examples of this. Yet the Earth has these hotspots where real damage must have occurred. So these things didn't make sense without a new class of impactors and this turned my attention to the potentiality of a very dense meteor sized object hitting the Earth. So in this paper we explored the Physics of CUDO's hitting and puncturing the surface of the Earth.

Q. How long did it take you to publish the paper? From the initial motivation, to gathering the research, to the publication of it.

A. We were very excited in the beginning. It sounded like, on our account, something very new had come to my mind, so we rushed the first paper a year and a half ago that was perhaps not as

well prepared as it should be and was not received very well. Many Geologists said there was too much Physics, and many Physicists said there was too much Geology. After some time I had discussed with other people who were interested in the paper and I realized that I really did have something exciting to say and from the reaction of people I realized that what I should have done was publish a paper that was more focused on my subject area of Physics and not a mixture of Geology and Physics. So we had two serious attempts, one which was a paper which was not ready to be published and one which was complete and successfully published and accepted. We still have the Geological considerations which we have not completed but I am not obviously a qualified Geologist so I would need to find an interested Geologist to support me with this research.

Q. Do you feel that the evidence for CUDO's that you have provided in this paper is sufficient enough to create a case for their existence?

A. I feel that there is an obvious connection and one has to focus on what one knows but there is no clear explanation. There is no clear explanation why the Hawaii hotspot has been stable for nearly 70 million years, and all we can assume is that something hit the Earth, possibly a CUDO, and to help support this I would need to possibly find such a puncture on the moon, or mars, or even other similar punctures here on Earth, and they would have to have a very unique feature in these punctures which we do not yet have. However, it is important to remember that if we do not prove its existence, we didn't disprove it. If you want to find something, then not finding that thing is not evidence against its existence. New ideas take time to prove because we don't know all of the facts correctly and so we have to explore and learn what is missing in our ideas in order to prove or disprove its existence.