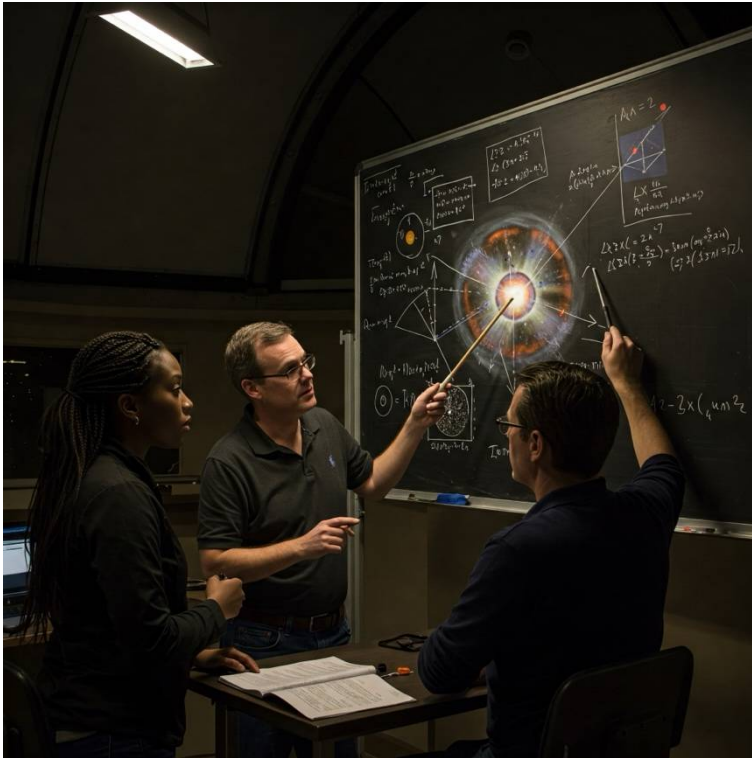


The universe is full of explosions

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Now I'm an astronomer and do research on explosions in the Universe. But when I was a high school student, I was not good at physics and didn't like physics lectures at that time. What led me to the study of astronomical explosive events? I used to think physics was just about memorizing complex formulas and applying them, and that it was a huge struggle to study. However, when I was in my second year of high school, I took a special lecture on special relativity and its effects on astronomy. In this lecture, I learned that all physics formulas can be derived from the principles of nature, and I was fascinated by the idea of special relativity. For example, I was very interested in the famous equation  $E=mc^2$ , which states that mass is equivalent to energy. Because I kept that in my memory,

I tried to read physics textbooks such as the Feynman lectures on physics when I entered university. And finally, I found physics very interesting and decided to major in astronomy.

Imagine looking up at the night sky in a place with clean air. You can see many stars and think they are beautiful. But have you ever wondered what happens to them in the distant future? These stars have a lifespan, and some of them end their lives in spectacular explosions called supernovae. These are very powerful events and release energy equivalent to ten billion times what our Sun radiates in one year. How often do supernovae happen in the near universe? Surprisingly, you can find newly reported supernovae on websites every day, discovered by observatories, professional astronomers, and even amateur astronomers! If you are the first to discover one, you can get a reward.

Not all supernovae are the same, though. They are classified as Type Ia, Type II, etc., according to how their luminosity changes over time and what elements they contain. These types are thought to represent the nature of stars that explode. For example, Type Ic supernovae are thought to come from stars more than 30 times heavier than our Sun. Astronomers have made great strides in understanding supernovae, and there are aspects of supernovae that we know in a unified way. But many fascinating mysteries remain. For example, what happens just before stars explode? What determines what remains after the explosion?

Even beyond supernovae, the universe is full of explosive events, though you cannot see them with the naked eye. I am currently researching one of the most powerful events: Gamma-ray bursts (GRBs). These were first discovered in 1967, but we still don't fully understand how they work. The key to uncovering their secrets lies in studying their

different kinds and their connection to supernovae. Just like supernovae, GRBs have diversity. They are divided into two main groups based on how long they last: short GRBs and long GRBs.

Long GRBs are particularly interesting to me. They, too, have two distinct subgroups: LGRBs and low-luminosity GRBs (llGRBs). While LGRBs are about ten thousand times brighter and last around 100 seconds, llGRBs are dimmer and last about 1000 seconds. Despite these stark differences, both LGRBs and llGRBs are associated with the same kind of events; Type Ic supernovae! Often, after a long GRB, a peculiar Type Ic supernova is found in the same location. However, some Type Ic supernovae occur without any associated GRBs. This leads to intriguing questions: Do LGRBs and llGRBs originate from the same kind of event? If so, what makes them so different? Are all Type Ic supernovae actually associated with GRBs, and are some undetectable to us for some reason? Sixty years after their discovery, GRBs still hold more mysteries than answers.

Last year, the Einstein Probe (EP) satellite was launched, and it has already reported many llGRBs and similar events. I am now developing a program to automatically conduct follow-up observations of these EP events. By getting detailed information on how their luminosity changes, I hope to shed light on their origins.

As I mentioned above, I didn't like physics lectures, but I was fascinated by a special lecture and decided to major in astronomy. What is taught in school is not what that discipline is all about. You can find fascinating things (like quantum information theory or exoplanets) at bookstores, on the internet, or elsewhere. I want you to find out what you want to know outside school. At first, interesting study is difficult to understand, but you can ask teachers, look things up online, and ask chatGPT. You will learn and you will want

to learn even more.

Since I started my astronomy major, I have changed my interest several times. When I was in my junior year, I wanted to know what the very early universe looked like. But when I was in my senior year, I was interested in developing observational instruments. And now, I am fascinated by GRBs. Shifting interest is not a bad thing; what I have done is useful in another domain. Doing what you think is interesting now will yield good results. Don't hesitate to start new things.

I used Grammarly and Google Gemini to correct grammar.