# RUMBLING IN THE COSMOS

**Astrophysicist Elizabeth Ferrara was one of nearly 200 scientists who have been gathering data on pulsars for 15 years. Their work found the first evidence of gravitational waves at extremely low frequencies, according to the North American Nanohertz Observatory for Gravitational Waves.** FAYE LEVINE/UNIVERSITY OF MARYLAND



## Pulsars point the way on gravitational waves, via black holes on an almost unfathomable scale

**Sarah Sekula** Special to USA TODAY

Two of Elizabeth Ferrara's favorite things are gravitational waves and pulsars (dense cores of exploded stars). Her job as an astrophysicist at the University of Maryland allows her to geek out on both. ● Getting to research pulsars to study black holes producing gravitational waves? Now that's a dream come true.

The fascination began at a science museum as a kid when she learned how the orbits of the planets were defined by the sun's gravitational pull. "Take that and scale it up a billion times," she says, "and you have orbits that can change the universe, changing the distance to the pulsars we observe by about the length of a football field. That's simply amazing to me!"

The pulsars, which she describes as weird objects halfway between a star and a black hole, are mysterious. "They only exist because one of the four forces in the universe, the strong nuclear force, is stronger than gravity for a very specific set of circumstances," she says. "Add just a little more mass, and you get a black hole. Less, and you have a white dwarf. It's a neat stopping point that has created a really unexpected opportunity for gravitational-wave science."

Together with more than 190 other scientists, Ferrara has collected data over the past 15 years that led to the "first evidence of 'supermassive' (millions to billions of times the mass of the sun) black holes producing gravitational waves," she says. "These waves only occur for supermassive black holes in a binary system, orbiting another supermassive black hole."

Her work involves the discovery of pulsars. She then evaluates them for inclusion in NANOGrav — the North American Nanohertz Observatory for Gravitational Waves, an international collaboration exploring the low-frequency gravitational wave universe through radio-pulsar timing. Since 2009 she's discovered about 130 pulsars, a number of which have been added to the search for gravitational waves.

At the same time, other pulsars are being discovered through large radio surveys that scan the sky looking for these flashing objects, she says. This has helped scientists by improving their odds of finding gravitational waves.

"Given that this is the first time we've been able to observe our universe in this way," she says, it's possible there may be additional surprises, affecting our fundamental knowledge of physics.