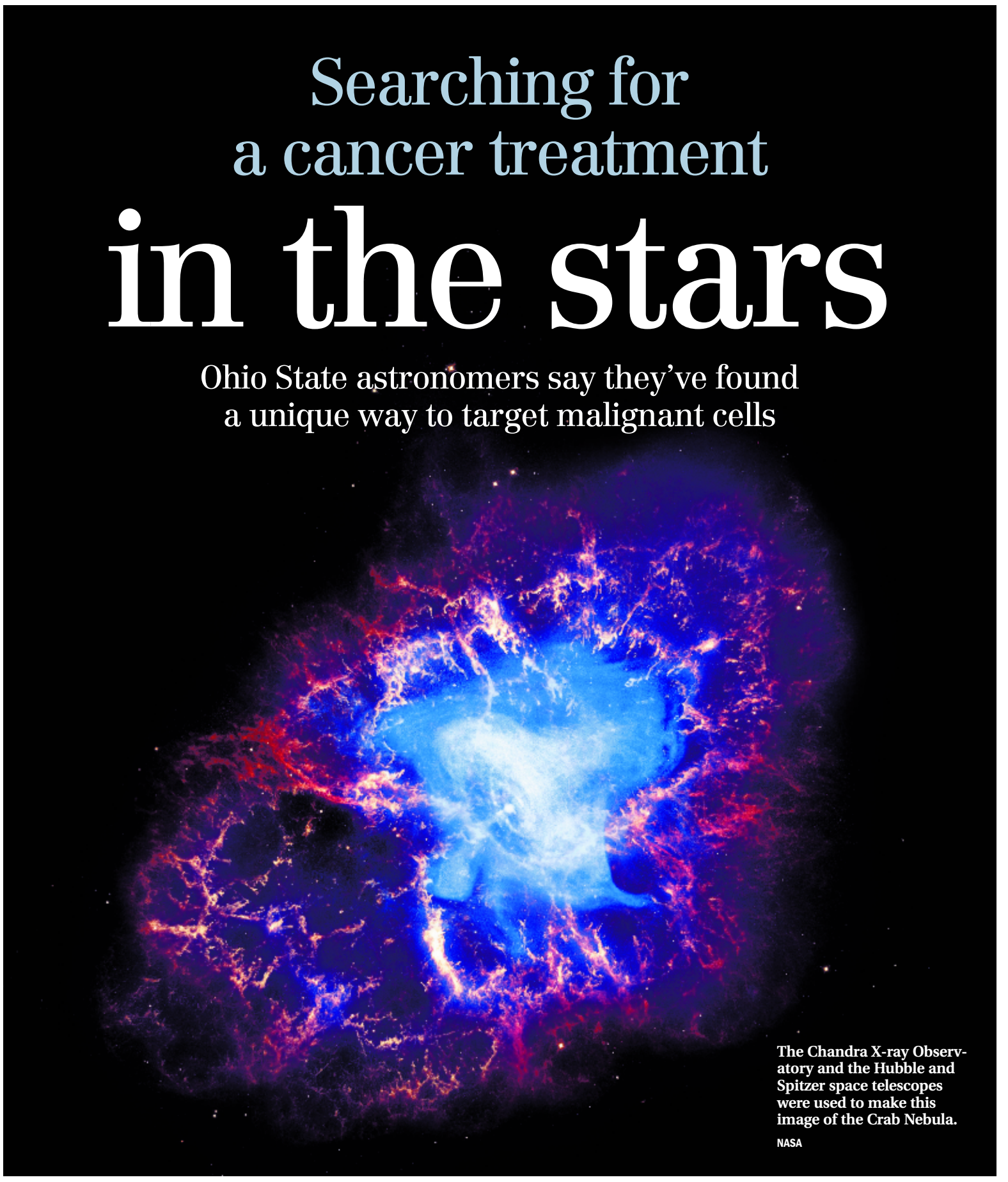
Searching for a cancer treatment in the stars

Ohio State astronomers say they've found a unique way to target malignant cells



The Chandra X-ray Observatory and the Hubble and Spitzer space telescopes were used to make this image of the Crab Nebula.

NASA

By Molly Gray | THE COLUMBUS DISPATCH

It is not uncommon to find inspiration in the stars. ★ But a possible cancer treatment? ★ Ohio State University researchers think their work with huge regions of space might lead to a way to kill the smallest cancer cells. ★ After studying how different elements absorb and emit radiation in stars and around black holes, OSU astronomers are working with cancer experts to create a radiation treatment that is tougher on malignant tumors than current treatment yet won't damage the rest of the body.

Astronomers Anil Pradhan and Sultana Nahar propose that their concept, called Resonant Nano-Plasma Theranosics, can use X-rays to fire electrons at malignant cells in hopes of destroying them.

"This could revolutionize both X-ray imaging and cancer therapy," Pradhan said.

The breakthrough moment came when Pradhan was talking with a longtime friend and collaborator, Yan Yu, a medical physicist at Thomas Jefferson University Medical College in Philadelphia, Pa.

Yu had said he wanted a way to target radiation in cancer treatment. Pradhan told him about a new discovery in X-ray astronomy called resonance peaks — the principle that metals absorb X-rays better at certain frequencies.

"Then we thought, 'If we can find those energies where X-rays are absorbed through these peaks, we can probably have considerable reduction in X-ray doses and improve effectiveness (in cancer treatment),' " Pradhan said.

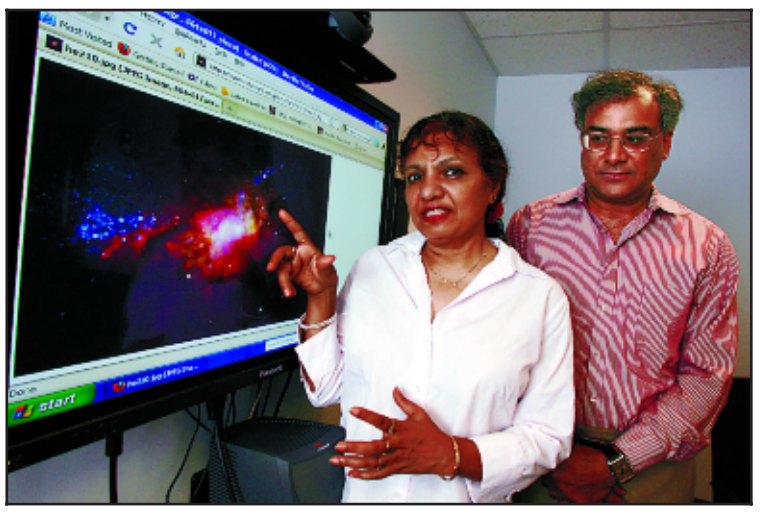
Their work started during their work with NASA's Chandra X-ray Observatory.

X-ray telescopes give a more comprehensive view and understanding of the heat and energy of stars than optical telescopes. X-ray telescopes basically have two components: a large mirror and a detector.

Astronomers zoom in on X-rays emitted from a star's surface and use the mirror to angle them toward the detector, which is made up of hundreds of tiny silicon pixels.

"The X-rays cause ... electrons to eject off from the silicon pixels and then the detector collects those electrons and can tell from where the X-ray is coming from and how much energy it has," said David Burrows, an astronomer at Penn State University.

It was the detector mechanism, and subsequent electron ejection, that sparked the interest of Nahar and Pradhan.



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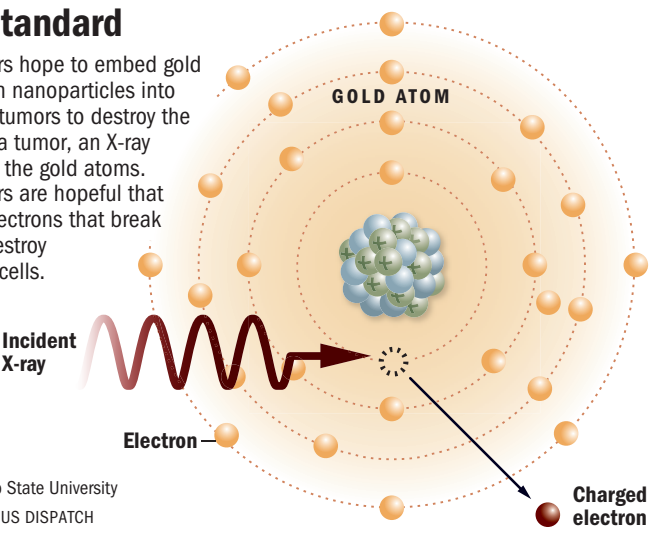
OSU astronomers Sultana Nahar, left, and Anil Pradhan

Gold standard

Researchers hope to embed gold or platinum nanoparticles into malignant tumors to destroy the cancer. In a tumor, an X-ray penetrates the gold atoms. Researchers are hopeful that charged electrons that break free can destroy malignant cells.



Source: Ohio State University
THE COLUMBUS DISPATCH

When a heavy-metal atom is hit with particular X-ray frequencies, the electrons vibrate and break free from their orbits around the nucleus, creating an electrically charged gas around the atom.

After looking at myriad elements, Nahar found that heavy elements emit more electrons when they are hit with X-rays at certain energy levels.

"Being in the atomic physics, we could guess that there is some energy region where there was a maximum electron production," Pradhan said.

Using spectroscopy — the study of the interaction of matter and radiated energy — Nahar calculated the specific energy regions that allowed the optimal amount of electron ejection for many elements.

They selected gold and platinum as prototypes because, as the 78th and 79th elements in the periodic table, they are heavy elements with large particles and can therefore be more effective against the malignant cells, Nahar said.

So how does all of this come into play as a cancer therapy?

Nahar and Pradhan hope to marry X-rays with nanoparticle technology to better target radiation to a tumor, rather than sending it throughout the entire body.

They say they can embed gold or platinum nanoparticles into the patient's tumor and then direct X-rays that will send the element's electrons out to destroy the cancer.

"Ejected electrons go to the surrounding bad cells and destroy them, which is why it was important to find the frequency where the most electrons are being ejected," Nahar said.

Nahar and Pradhan have been working with medical experts, including Yu.

"It's something like this — you plant a smart device (into the tumor) that you can later activate or stimulate by using highly-tuned X-rays," Yu said. "The device will begin to expel electrons to the tumor and you can stop it when there is sufficient damage or you can continue it if the tumor is still active."

The concept also is being proposed as a tumor-imaging technology, Pradhan said. Much like the imaging process used to photograph the stars, doctors should be able to use the expelled electrons to create an outline of a tumor.

Yu said the idea of fighting tumors with electrons is revolutionary.

"Conventional types of treatment ... just shoot radiation through the body and it does not discriminate where the radiation takes effect," Yu said. "There is no internal collaboration between the external energy and the internal receiver."

There are still several obstacles, including developing a way to deliver the nanoparticles to a tumor.

"That is something we mainly have to leave up to our colleagues in the biomedical engineering field," Pradhan said. "They need to develop intelligent nanoparticles."

Another is the need for a more specific X-ray machine.

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