For New Cancer Therapies, Look to the Stars

By Jennifer Ouellette | Tue Jul 26, 2011 06:10 AM ET

When you look up at the night sky -- whether with the naked eye or with your spiffy Celestron telescope -- how often do you stop to consider which chemical elements might be present in their gassy glow? Astronomers use several different methods to study how different chemicals emit and absorb radiation inside stars (and even black holes), but they get widely varying results.

Now astronomers think they might have a new technique for doing so, with an added bonus: it could also lead to a potential new cancer radiation treatment capable of precisely targeting tumors without damaging the surrounding healthy tissue. Anil Pradham, an astronomer at Ohio State University described the research at the International Symposium on Molecular Spectroscopy in June.

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Star Stuff

Nahar and his collaborators initially were interested in determining the various chemical abundances inside stars, based on how electromagnetic radiation flows through and emits from those stars. This produces a spectrum of different wavelengths of light; different wavelengths will be absorbed (or not) depending on which chemicals are present. That determines a given element's "signature."

Pradhan conducted computer simulations to calculate how individual atoms would react to every wavelength of energy -- no small feat. They logged many hours at the Ohio Supercomputer Center to complete the analysis.

But the effort was worth it. Pradhan found that some of the prior measurements of chemical abundances inside stars might be off by as much as 50 percent. They were also intrigued by how certain heavy metal atoms absorb radiation: they emit low-energy electrons when exposed to x-rays at specific energies. For example, bombarding iron, gold and platinum with a small dose of x-rays tuned to a narrow frequency range results in a burst of low-energy electrons.

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Both x-rays and heavy metals like gold and platinum are routinely used in medical imaging and cancer treatment, hinting at more practical applications. It's the fine-tuning of the x-ray source that seems to be key.

"From a basic physics point of view, the use of radiation in medicine is highly indiscriminate," Pradhan explained in the OSU press release. "Really, there has been no fundamental advance in x-ray production since ... [William] Roentgen invented the x-ray tube, which produces x-rays over a very wide range."

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X-Rays Mark the Spot

Ever since x-rays were first discovered in 1895, they have proved to be a double-edged sword. On the one hand, they are useful for medical imaging and diagnosis.

This is due to a unique property of x-rays. They pass through most materials, depending on the size of the atoms that make up that material. The soft tissue in the body is composed of smaller atoms and hence doesn't absorb X-rays very well, whereas the calcium atoms in the bones are much larger and do absorb X-rays.

But X-rays are also a form of ionizing radiation. An ion's electrical charge can lead to unnatural chemical reactions inside cells, particularly at the higher energy levels of X-rays. It can break DNA chains, causing the cell to either die or develop a mutation and become cancerous, which can then spread.

Many of the early x-ray pioneers became sick and/or died from constant exposure to this ionizing radiation. Yet it can also kill off cancer cells as well as cause them. So some experimentalists began using the rays to treat disease.

Only a few days after the announcement of Roentgen's discovery in December 1895, a Chicago-based electrotherapist irradiated a woman with a recurrent cancer of the breast and destroyed the tumor. By the end of the year, several other researchers had noted the palliative effects of the rays on cancers. It has been a mainstay of cancer treatment ever since.

But radiation treatment is a coarse instrument at best, since it destroys surrounding healthy cells as well as cancerous tumors. Much research is underway for targeted methods to reduce the collateral damage and attack just the cancer cells, including embedding nanoparticles inside tumors.

The OSU scientists call their technique Resonant Nano-Plasma Theronostics, since the tuned x-rays knock electrons in heavy metal atoms from their orbits to create an ionized gas (plasma) around the atoms at the nanoscale.

With his OSU colleague Sultana Nahar, Pradham envisioned a prototype device capable of generating x-rays at the key frequencies to trigger a flood of low-energy electrons in platinum and gold, based on their computer simulations. Gold or platinum nanoparticles would amass naturally in cancerous tumors in the body, and could then be zapped with the focused x-ray beam.

The resulting spurt of low-energy electrons would kill the cancer cells, but would not have sufficient energies to move beyond and attack the surrounding healthy cells. Ultimately, the goal is to combine radiation therapy with chemotherapy, using platinum as the active agent.

So the next time you're outside star-gazing, take a moment to wonder at how amazing it is that processes occurring within the interiors of stars might also help us cure cancer back on Earth.