Detecting dusty clouds and stars in our galaxy in a new way

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The center of our Milky Way galaxy is a wondrous place full of huge star clusters, dust clouds, magnetic filaments and a supermassive black hole. But it can be a confusing place, too, posing challenges to astronomers trying to image these exotic features and learn more about where they are located in the galaxy.

Northwestern University's Farhad Zadeh has discovered a new tool for detecting dusty clouds and stars: simply take a picture using radio waves. He is the first to identify what he calls radio dark clouds and stars. Stars in the early and late phases of their evolution are shrouded by huge dusty envelopes in the form of dust and gas outflows.

"When you see these dark stars or clouds in radio wavelength images, it tells you something very interesting," Zadeh said. "We immediately know there is a cold gas cloud or dusty star mixing with a hot radiative medium and that an interaction is taking place. Knowing details of these clouds is important because the clouds can produce stars and also provide material for the growth of black holes."

Zadeh is a professor of physics and astronomy in the Weinberg College of Arts and Sciences and a member of Northwestern's Center for Interdisciplinary Exploration and Research in Astrophysics (CIERA).

Unlike in the optical, X-ray and infrared wavelengths, it is unusual to see a dark feature with radio waves. Radio is a long wavelength and therefore doesn't get absorbed easily and typically passes through

whatever is in its way.

Initially Zadeh thought maybe the dark features he saw on the radio images he was studying were nothing, but then he connected the features to five known dense molecular and dusty clouds located in the center of our galaxy, some near Sagittarius A* (Sgr A*), the black hole.

"This technique provides very good sensitivity of faint dusty features, and it can produce images with even higher resolution than many other telescopes," Zadeh said. "It is an initial observation that tells you something is there that needs to be studied more closely."

In addition, astronomers can measure the size of dusty stars using this new technique.

Zadeh will present his results at 11:30 a.m. PST (Pacific Standard Time) Tuesday, Jan. 8, at the 221st meeting of the American Astronomical Society in Long Beach, Calif. He also will participate in a press conference on the galactic center at 12:45 p.m. PST the same day.

The interaction of a cold dust cloud with a hot radiation field results in a loss in the continuum emission and appears as a dark feature in the radio wavelength image, Zadeh said. The dark features that trace the embedded molecular clouds provide astronomers with the size of the cloud in three dimensions.

Although not part of the work he is presenting, Zadeh said a good example of a dusty cloud that could be imaged with his technique is G2, the tiny cloud that is fast approaching Sgr A*, our galaxy's black hole.

The cloud now is too close to the black hole for Zadeh to take an image, but he is looking at earlier data to see if he can locate G2 as a radio dark cloud.

"If the cloud was farther away from the black hole than it is now, we could detect it," Zadeh said.

For his study, Zadeh used Green Bank Telescope maps and Very Large Array images from the National Radio Astronomy Observatory. The National Science Foundation (grant AST-0807400) supported the research.

The title of Zadeh's paper, which was published Nov. 1 by the *Astrophysical Journal Letters*, is "Imprints of Molecular Clouds in Radio Continuum Images."

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