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Space's black holes yield new secrets to scientists' gaze

Technology has taken the science of sky gazing to a whole new level. Thanks to powerful computers and equipment, such as the Hubble telescope, astronomers can peer into the deepest corners of the universe to shed light on its celestial bodies.

One bizarre body, the black hole, has had its profile updated recently with the discovery of medium-sized gravity hogs that were observed by a team of scientists, including Roeland van der Marel from the Space Telescope Science Institute in Baltimore. With a doctorate in astronomy from Leiden Observatory in the Netherlands, Mr. van der Marel has been studying the formation of galaxies for more than a decade and took some time to explain the magic behind the black hole.

Q: When were black holes first discovered?

A: The existence of black holes was first suggested a few hundred years ago. In 1915, Einstein's Theory of Relativity provided the first proper explanation of black holes, although Einstein himself thought of them mostly as a mathematical curiosity. It has been very surprising for astronomers to learn, first quite slowly and now at a much more rapid pace, that black holes are actually quite common in the universe.

Q: What is a black hole?

A: The concept of a black hole is quite simple to understand. It is only when you begin to seek out the details that it becomes very complicated. The first thing to recognize is that a black hole is an object so massive that nothing can escape its gravitational pull. Not even light can escape.

To understand a black hole, consider our own Earth's gravitational pull. It is not easy to break this pull and escape through our atmosphere, but it is not impossible. But now imagine that the Earth was somehow squeezed to the size of a marble. The gravitational pull on the surface would then be so large that nothing could ever escape. It would be a black hole.

JOE SZADKOWSKI

Tech magic

The black holes astronomers have found in the universe are even much more massive than our Earth. The black hole at the center of M87, an elliptical galaxy 50 million light years away in the constellation Virgo, weighs as much as three billion of our suns, yet for all of its weight, or mass, the total size is no larger than our solar system.

Q: How do black holes form?

A: A stellar-mass black hole forms when a star collapses under its own weight. This happens because the nuclear fuel that makes the star shine runs out, creating a supernova explosion. This leaves a black hole that is just a little heavier than our own sun.

We don't quite know yet how the much heavier black holes astronomers see in the centers of galaxies form. There are many theories though, and we hope to find out soon.

Q: How do you know when there is a black hole?

A: Black holes have such a strong gravitational pull that stars and gas near them move much faster than they otherwise would. By observing how fast stars and gas move, astronomers can determine whether they are being pulled upon by a black hole.

Q: How are you able to see black holes?

A: You can never see them directly, because they don't emit light. However, we still can study them by observing material close to them. For this we use telescopes, although not the ones that you can look through with your eyes.

The clearest views of the universe are obtained wherever there is the least amount of atmosphere obscuring our view. Common problems are cloud cover, pollution or interference from streetlights. Large observatory telescopes are therefore built on mountaintops in places such as Mauna Kea on Hawaii, Kitt Peak in Arizona, or the Andes Mountains in Chile. As a scientist, I compete with other astronomers to get awards of time on such telescopes. When I succeed, I point them at objects I find interesting.

The famous telescope that almost everyone knows about is the Hubble Space Telescope. Hubble is in orbit around Earth, so one cannot visit it and peer through it. Individuals at the Space Telescope Science Institute schedule the telescope's time and plan how it will do its required tasks.

Q: What happens if you get too close to a black hole?

A: The gravitational pull would become so strong that you, or any object, would become pulled or stretched apart. But if we ignore this unfortunate reality for the moment, there are quite a few interesting phenomena that would present themselves.

Imagine that we could send a space ship into the direction of the black hole. As, from a distance, we monitor it moving into the black hole, it would become redder in color. This is because light particles have to fight to get away from the gravitational pull. If there was a clock attached to the ship, and we could see the time, the clock would move slower and slower as the ship got closer to the center of the black hole. The clock would appear to us to have stopped when the space ship crosses a communications boundary called the event horizon. We would never see the space ship make it all the way into the black hole.

Q: Are black holes at the center of all galaxies?

A: This question is something that currently occupies the thoughts of myself and many of my colleagues. We have found a lot of them, but we don't know if every galaxy has one. If not, we would like to know why, and what that tells us about how black holes have formed.

We do know that massive black holes exist in places other than galaxies. We recently announced we have identified what we call medium-sized black holes. These exist in globular star clusters that are much smaller than a galaxy; they "only" have some 1,000 to 1 million stars.

What this shows is that black holes exist in the middle mass range between the small black holes that form from individual stars and the big black holes that exist in the centers of galaxies. We think there is some connection between how globular star clusters and galaxies are formed, which may eventually provide new insight into the origin of these systems.

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Wax is applied to an outdoor sculpture, Henry Moore's "Two Piece Reclining Sculpture," by conservator Lee Aks outside the Hirshhorn. Outdoor works present a special challenge to conservators.

Photos by Maya Alleruzzo/The Washington Times

Chief conservator Susan Lake cleans "In the Infield was Patti Peccabi," by Ed and Nancy Kienholz inside the conservation lab at the Hirshhorn. "We use materials so you can distinguish the artist's work and easily remove them," she says.

Conservators do an artful job

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Conservator Clarke Bedford works on touching up a still life by Patrick Henry Bruce, "Painting: Still Life Table With Glass," at the Hirshhorn Museum and Sculpture Garden.

ing, a synthetic paint might be used on top of the oil for the area that needs to be repaired.

Had he had more than a few weeks to get "Classical Head" ready, Mr. Bedford would do a more thorough job, he says.

The piece has had a previous, not-so-well-done nose job, during which the damaged face was fixed with epoxy.

"A more complete treatment would be to remove all the discolored epoxy fills and replace them using wax, marble dust and dry pigment," Mr. Bedford says. "Those materials would be able to mimic the translucence of the marble. The toning is something of a compromise."

It also is important that the conservator's work is reversible, meaning that the "fix" can be removed, he says.

The earlier nose job — done many years ago — is an example of an irreversible treatment: the epoxy is stronger than the marble, meaning that any removal of the old conservation job may damage the original sculpture.

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One challenge for the conservator is to figure out what materials the original artist used. This can be particularly difficult in modern art, which is what the Hirshhorn showcases, since modern artists do not limit themselves to old faithfuls such as oil and watercolors.

The conservator can only do a good job — making sure the material for restoration is reversible and clearly distinguishable — if he knows the original material used.

"The examination procedure is as important as the actual treatment," Ms. Lake says.

To find out about the original materials, conservators use various technical methods. Sometimes removing a tiny sample from a painting (in a place where it won't be noticeable) and looking at it under a microscope can show the conservator how many layers of a certain paint was used.

Another way of determining original materials and techniques can be historical documentation, especially archival photos, Mr. Bedford says.

Of course, the artist can be the best resource if he is living. (If not, a studio assistant or family member can be helpful.) Sometimes, however, the artists are not sure what they used. Their concentration was on an effect, and they mixed and matched materials to accomplish that effect, Mr. Bedford says.

"For that reason, we have to use some inventiveness ourselves to mimic the work of art," he says. "I don't know how many times I've brought something from home to use because it had a surface or look that approximated [the original piece]."

Sometimes, conservators find out that the original material has "inherent vice," meaning there is no fix for it. It is going to break or crumble, and there is nothing the conservator can do without completely redoing the piece.

A good example of this is American sculptor Paul Thek's "Fishman," which shows a latex figure strung up in a tree, Mr. Bedford says. The sculpture is from the 1960s.

After 40 years, the latex has broken down, and conservators are at a loss.

"Latex just doesn't have a very long life span," Mr. Bedford says.

Fishman is now lying in a coffin-looking box. He is old, cracked and broken.

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Restoration work on the old masters often involves cleaning off dirt and old, cracking varnish, says Barbara Berrie, senior conservation scientists at the National Gallery.

"Nowadays, the cleaning is done by using synthetic solvents," Ms. Berrie says.

Before the cleaning starts, however, it is important to try to determine (as with modern artists) what materials the painter used in the paints.

X-raying pictures can help determine if the paint contains lead. It shows up as white dots on the X-ray, Ms. Berrie says.

If a sample needs to be taken, usually a piece smaller than a millimeter in diameter is cut out of the painting. The sample might be put under a microscope or scanned to determine the number of layers and type of paint used.

After making determinations about the original paint's composition, the conservator can create a cleaning solution that removes the varnish, but leaves the underlying oil untouched, Ms. Berrie says.

Depending on the painting, a combination of water, detergent and solutions such as acetone can be used to clean oil paintings.

While conservation nowadays is well documented and scientific, a hundred or more years ago, restoration work was done by artists, often driven by the need to make money.

"In the old days, you fixed it to make it look right," Ms. Berrie says. "It was a way to make it look good and sell it for more."

In the 20th century, conservation became a profession with its own standards and code of ethics, which mandated that a conservator not mess with the artist's work, she says.

"I think it's important to maintain the integrity of the artist's work, and not just mix in our work with their work," Ms. Berrie says.

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While fixing and preserving are the main goals of a conservator, other considerations exist, too.

What about if the artists would have wanted a certain piece to "age naturally"? Is it right for the conservator to try to reverse the aging process?

"We have a long discussion before deciding what exactly we're going to do," Ms. Lake says. "We are trying to balance aesthetic issues with the need to conserve the objects."

Take outdoor sculptures, for example. They are exposed to a much tougher environment than art objects housed in museums. Bronze sculptures turn green if they are not waxed often.

"From a purely preservation standpoint, the outdoor bronzes should be constantly coated with heavy layers of wax," Mr. Bedford says. These heavy layers of wax, however, can make the sculpture look more homogeneous, which may not be desirable from an aesthetic standpoint, he says.

One solution the Hirshhorn is experimenting with is repatinating some of the outdoor pieces, returning them to their original appearance.

Repatination is a chemical process in which a combination of materials, such as ferric nitrate, is applied to the bronze, changing the color to dark brown, green or black — in other words, changing the color to make it look aged depending on the composition of the bronze and the outside environment.

"To some extent, the question of striking a balance between accepting and denying the passage of time is a question of taste, and it has a cultural element to it," Mr. Bedford says.

Generally, Europeans are more accepting of deterioration than Americans are, he says. Americans tend to want things to look "perfect."

The American concern about preserving art may have its roots in the fact that we do not have as much of it as Europe, where every church and square is packed with paintings and sculptures, Ms. Berrie says.

"We don't have that tradition here. We have so much less, we want to take care of it," she says.

Taking care of it can be fun and challenging at the same time, agree the conservators.

"The ego hit is that someone at some point is going to redo your work, however well you did it," Mr. Bedford says.

But getting that up-close look at a master at work can be rewarding, too, Ms. Berrie says.

"Seeing the effort that went into the work is marvelous," she says.