Smithsonian

Spotlight on Science at the Smithsonian

Bi-Weekly Newsletter | Vol. 5, No. 3 | 9 February 2007

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Spotlight on Science at the Smithsonian is a bi-weekly electronic newsletter about Science at the Smithsonian. It is produced for the Smithsonian community by the Office of the Under Secretary for Science. To subscribe to the newsletter or Podcast, visit science.si.edu.

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Introduction from the Under Secretary for Science

In this installment of Spotlight on Science we introduce a new format, which we hope will make the stories more reader-friendly for viewing on the web. Let us know what you think of it!

In our first story we learn how Smithsonian astronomers have made an important advance in the study of some of the strangest objects in the cosmos–black holes. Using X-rays emitted by surrounding gasses, the astronomers found that certain black holes are not only incredibly massive, but also spinning at an astonishingly fast rate. Back on earth, we join genetic researchers trying to pin down the pathways of disease by tracing the global movements of disease-carrying mosquitoes. Finally, we look at an exciting new development in the race to study and conserve the world's vanishing biodiversity. Smithsonian botanists have teamed up with computer scientists in an ambitious project to put the vast information resources of the Smithsonian at the fingertips of scientists exploring remote field areas.

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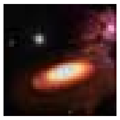

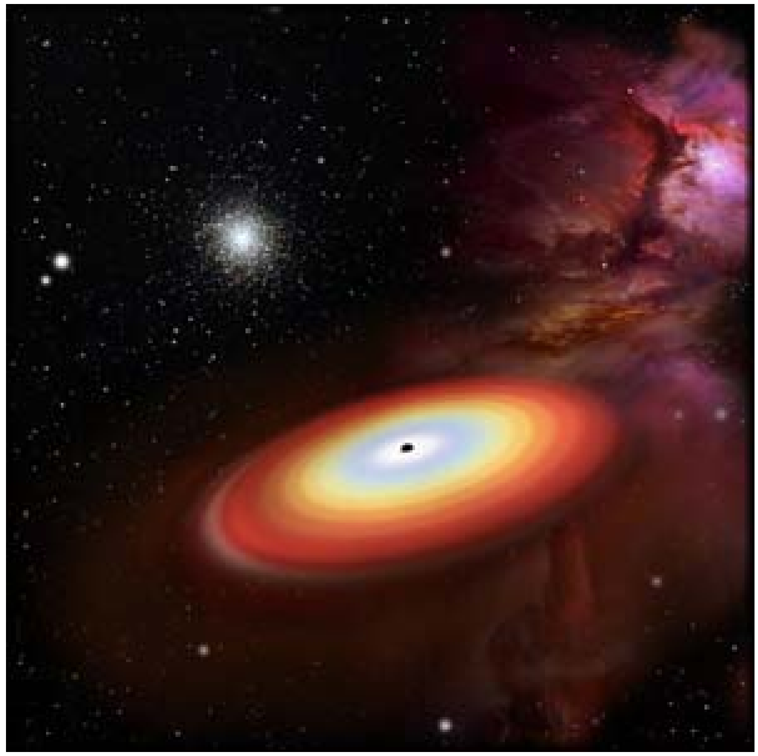

The super hot gasses at the inner rim of the disk surrounding a black hole emit X-rays that allow astronomers to calculate the black hole's spin. (Artists conception.)

Measuring a Black Hole's Spin

Smithsonian Researchers

Jeffrey McClintock and Ramesh Narayan (Harvard-Smithsonian Center for Astrophysics)

Findings

An international team led by Smithsonian astronomers has used X-ray emissions to accurately measure the spin of three black holes. One of the black holes, with a mass equivalent to 14 suns, spins at the astonishing rate of 950 revolutions per second. This is close to the theoretical maximum set by relativity theory.

Why It Matters

Black holes are among the most fascinating objects in the universe. Formed by the collapse of massive stars, they generate intense gravity fields that severely warp space and time, producing strange effects. Yet they are also exceedingly simple objects, fully described by just two numbers: mass and spin rate. The masses of many black holes are known, but until now their have been no reliable estimates of spin. Black holes are fundamental to our understanding of gravity, as well as other aspects of the universe, and this result is a major advance in understanding how they work.

Methods

The key to measuring a black hole's spin is the temperature of X-rays emitted by matter being sucked into the hole. The swirling matter forms a super-hot disk, with the hottest X-rays being emitted by the disk's inner edge. The faster a black hole's spin, the closer in the inner edge contracts and the hotter and brighter the X-rays glow. Using data from NASA's Rossi X-ray Timing explorer satellite, the researchers were able to measure the temperature of the X-rays. From there they could calculate the inner radius of the disk and the black hole's spin.

What's Next

This method can be applied to other known black holes in the universe. Knowledge of the spin rates of black holes will help researchers develop models for related phenomena, such as gamma ray bursts, which are the brightest flashes in the universe.

Reference

J. Mclintock, R. Shafee, R. Narayan, R. Remillard, S.Davis, and L-X Li. The spin of the near extreme Kerr Black hole GRS 1915+105. *The Astrophysical Journal Letters*. 2006.

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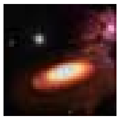

Measuring a Black Hole's Spin

Spreading Mosquitoes and Disease

Electronic Guides for Field Researchers

Southern House Mosquito laying eggs. Image courtesy of Centers for Disease Control.

Spreading Mosquitoes and Disease

Smithsonian Researchers

Robert Fleischer (Smithsonian Genetics Program), Julie Smith (Smithsonian Genetics Program)

Findings

The disease-carrying southern house mosquito (*Culex quinquefasciatus*) has spread worldwide with the unwitting help of human beings. Hawaiian populations of the mosquito were brought to the islands from sources in the Americas in the 1820s, but genetic results indicate that more recent introductions probably come from the South Pacific. These new immigrants can tolerate colder temperatures, allowing the mosquitoes to spread to higher elevations in Hawaii. Globally mosquito strains show more regional genetic differentiation than previously suspected, which may account for their varying ability to carry different diseases.

Why It Matters

As the world becomes increasingly connected the need to understand the pathways of emerging diseases and their vectors has become progressively more urgent for human health and the health of livestock and wildlife. In Hawaii the southern house mosquito is a principal carrier of avian malaria, which has devastated native bird populations and led to major extinctions. Elsewhere in the world the mosquito is ubiquitous in the tropics, especially near human habitations and carries such human diseases as elephantiasis and West Nile virus.

Methods

The sources of Hawaiian mosquitoes were traced through genetic analysis of live-caught adults, larvae, and preserved museum specimens. Samples came from 28 localities in the Pacific, Asia, East and West Africa, and the Americas. The genetic signatures of the Old and New World samples were distinct, with the Hawaiian samples revealing a mixture of both.

What's Next

The researchers are currently examining differences among the strains present in Hawaii that might affect their ability to carry avian malaria. As the mix of strains continues to change with new introductions and mosquitoes spread to higher elevations this could be a key factor in the fate of some native bird species.

Reference

Dina M. Fonseca, Julie L. Smith, Richard C. Wilkerson, and Robert C. Fleischer, Genetic Differentiation among Worldwide Populations of The Southern House Mosquito. *American Journal of Tropical Medicine and Hygiene,* 74(2), 2006, pp. 284–289.

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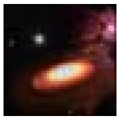

Measuring a Black Hole's Spin

Spreading Mosquitoes and Disease

Electronic Guides for Field Researchers

Botanist uses computerized field guide to identify a leaf. Image courtesy of John Kress.

Electronic Guides for Field Researchers

Smithsonian Researchers

W. John Kress (National Museum of Natural History), Rusty Russell (National Museum of Natural History), Norman A. Bourg (National Museum of Natural History), Ida Lopez (National Museum of Natural History)

Reference

Gaurav Agarwal, Peter Belhumeur, Steven Feiner, David Jacobs, W. John Kress, Ravi Ramamoorthi, Norman A. Bourg, Nandan Dixit, Haibin Ling, Dhruv Mahajan, Rusty Russell, Sameer Shirdhonkar, Kalyan Sunkavalli & Sean White. 2006. First steps toward an electronic field guide for plants. *Taxon*, 55 (3) 597–610

Findings

A partnership of natural history biologists and computer scientists is developing an electronic botanical field guide that will give field scientists in remote locations access to specimen data from the Smithsonian's extensive collections. Researchers will be able to photograph a plant in the field and the guide's novel image recognition algorithm will quickly match the image to similar specimens. Users will be able to quickly identify a plant, or determine if it is new to science.

Why It Matters

Biologists in the 21st century are faced with an overwhelming challenge. There may be as many as 10 million species of plants, animals, and microorganisms on earth, a large majority of which have not yet been described by science. Yet species-rich habitats such as tropical rainforests are being lost at alarming rates. Traditional methods of collecting and describing new species can take years of research comparing specimens with published literature and preserved specimens in natural history museums, herbaria, and botanical gardens around the world. New technologies such as electronic field guides are essential to meet the challenge of discovering and conserving the world's biodiversity.

Methods

Researchers created a digital archive of images of type specimens in the Department of Botany at the Smithsonian and field images of plant leaves. Using these images they developed a prototype guide for the flora of Plummer's Island in the Potomac River near Washington, D.C. The pc tablet-based computer system includes an algorithm that computes the similarity of leaf images. From a digital image of an unknown leaf, the program retrieves the most similar leaves in the digital archive. In tests, the prototype algorithm found the correct species nine times out of ten.

What's Next

So far 80,000 of the 85,000 specimens in the Smithsonian botanical vascular plant type collection have been digitized. The aim is to digitize all of the types and ultimately a representative sample of all of the Smithsonian's 4.7 million plant specimens. Currently work is being completed on an electronic field guide to the woody shrubs, trees and vines of the Washington area and soon work will start on a guide to the trees of Central Park in New York City and Barro Colorado Island in Panama. Future electronic field guides will link researchers in remote field areas with information resources and scientific colleagues worldwide.

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