Scientists clear up mystery of color

● **Why are certain** birds blue? Two KU researchers found out, and the results were published in this week's issue of Nature.

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Mike Yoder/Journal-World Photo

Rick Prum, right, KU associate professor and curator at the Natural History Museum displays a plum-throated cotinga bird from the KU collections. Prum and Rodolfo Torres, associate professor in math at KU, left, have completed research on the physical mechanics of the color of blue as it appears in birds such as this rare cotinga, captured in 1929 in Ecuador.

Early on in their quest to dismantle a 100-year-old scientific theory, Kansas University professors Rick Prum and Rodolfo Torres were not exactly birds of a feather.

Prum, curator of ornithology at the Natural History Museum, and Torres, a math whiz specializing in something called Fourier analysis, joined forces two years ago to determine why blue birds are, well, blue.

Prum knew that if they could pin down the reason behind birds' hues, it would lend valuable insight into their evolution. He also knew it would take someone like Torres to get him there.

Although the two now joke around like old friends, the first few weeks were more like Pythagoras and Charles Darwin going toe-to-toe over the mysteries of the world.

"I actually have a very cartoon understanding of the mathematics involved," said Prum, an associate professor of ecology and evolutionary biology.

Added Torres, associate professor of mathematics: "It took us roughly a semester to understand each other. In different fields of science, we sometimes speak a different language."

Over time, and with the help of Scott Williamson — a KU graduate student with undergraduate training in biology, math and computer science — they found common ground.

"He helped our communication," Torres said of Williamson. "We are very happy that he was part of the project."

When they finally found investigative harmony, they knew they were onto something big. Nature (the findings appear in the Nov. 5 issue) and other prestigious national journals agreed.

'Revolutionary ideas'

Back in 1994, Prum began noticing flaws in the logic that led scientists to conclude more than a century ago that birds were blue for the same reason the sky is blue.

That process, commonly called "Rayleigh scattering" for the British physicist John William Rayleigh, in essence asserts that all particles of light pass through

But bird feathers are so purely blue — without ultra-violet light cluttering the color — that they couldn't be produced in the same way. So why had no one questioned it before?

Someone had.

More than 20 years ago Jan Dyck, a researcher at the University of Copenhagen, published papers in obscure journals that passed under the radar of the scientific establishment.

"He had some real revolutionary ideas, but most people missed them," Prum said.

This time around, Dyck climbed on board with Prum.

Only there was a problem.

If this color was being produced by a highly complex system, it would require a fresh approach.

Enter Fourier analysis. Developed by a French mathematician, Fourier is basically a mathematical prism, deconstructing signals into individual waves. Prum stumbled upon it while reading research about the transparency of the cornea.

"I started with a real genuine belief or a real gut feeling that this method would work," Prum said. "My first job was to convince

After exhaustive analysis, they realized that there was order in the chaos of the feathers.

"It's not arbitrary," Torres said. "It's not like a crystal but there is some order. That was responsible for the color."

Unlike the colors in this newspaper, which are produced by chemicals called pigments, the blue that appears in the sky and in a blue bird are structural colors, produced by the visible interaction of light with natural structures.

But while the sky scatters light particles at the blue end of the spectrum, bird feathers, as well as oil slicks, appear blue because of the filtering of light through an arrangement of spaces.

Prum likened the feather to Swiss cheese. The cheese is keratin, a protein found in fingernails and hair. The rest is air, and the holes are arranged in such meticulous order only one color can escape.

For its study, the group settled on the plum-throated cotinga, found in the Amazon rainforest.

"It's incredibly blue," Prum said. So rarely seen is the cotinga that KU's specimen was bagged back in 1929 in Ecuador.

duction of color helps scientists get a better handle on the courtship of birds — the "hey-what's-your-sign?" activities that lead to mating and reproduction and the very mysteries addressed by Darwin over a century ago.

"It's a fundamental question of how this basic evolutionary process works," Prum said. "These birds are aesthetically beautiful, but they evolved by female preferences."

Without Fourier analysis, the patterns of the holes that affect those preferences could not have been determined. The hardest part, Torres said, was crossing the boundary between disciplines.

"I think it's the way science will go from now on," he said.

Only one question remains. Is this why the Jayhawk is blue?

"It's very likely," Prum said. "If it existed."

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