of their scheme in the February JOURNAL OF THE OPTICAL SOCIETY OF AMERICA B.

To circumvent the intrinsic noisiness of optical devices, Kurizki and his co-workers take advantage of strong interactions between an electromagnetic field and a stream of atoms passing through a special, porous structure fabricated from an electrical insulator. Known as a photonic crystal, this kind of structure prevents atoms embedded within it from spontaneously absorbing and reemitting light at wavelengths that fall within a certain range, creating a band gap (SN: 11/2/91, p.277).

The researchers suggest that by introducing a defect that disrupts the structure's orderliness in just the right way, they can use the defect to trap photons of a particular wavelength. The number of trapped photons initially present varies because of random fluctuations in the intensity of the laser light bathing the crystal.

But the uncertainty in the number of photons present can be removed by sending a beam of excited atoms, one by one, through the region of the defect. Alternately emitting and reabsorbing photons during their passage through such a structure, the atoms interact strongly with and modify the electromagnetic field associated with the defect-trapped photons.

Such interactions rapidly convert the electromagnetic field within the photonic crystal into a so-called photon-number state, meaning that a fixed number of photons is stored at the defect. In other words, the atomic beam acts as a kind of cleaning agent.

"The atoms remove the undesirable parts of the information, which is stored in the field," Kurizki says. "The remaining information within the field then conforms to what we would like to have."

The researchers can ascertain the existence of a particular photon-number state by looking for sequences in which each atom emerges from its interaction in an excited state. "One of the advantages of [our] strategy is that we can not only generate a photon-number state but also know in advance and adjust the conditions to get the right number of photons," Kurizki says. By establishing a well-defined photon-number state in a photonic crystal, researchers can exploit the ensuing certainty in the number of photons present for possible application in signal processing or optical computing.

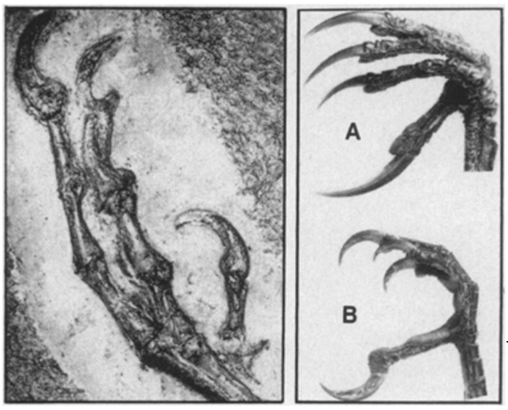
However, no one has yet confirmed experimentally that it's possible to create a photon number state. Even the design of materials with photonic band gaps remains rudimentary (SN: 3/28/92, p.206).

"From a technological point of view, this is still in its infancy," Kurizki says. "But these photon-number states are becoming a real possibility, and I think we are bound to see them within a relatively short time." *— I. Peterson*

Flight: A bird hand is worthy in the bush

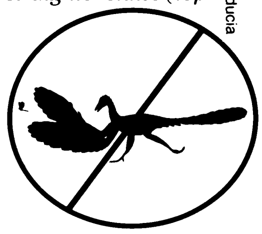
By examining the claws on the most famous fossil animal, an ornithologist has scratched open an old and bloody debate over how birds developed the ability to propel themselves through the skies.

Most paleontologists in recent years have backed the theory that birds evolved from feathered dinosaurs that ran along the ground jumping after insects. But the new work suggests that the earliest known bird had claws designed to perch in trees, countering the "ground-up" theory for the origin of flight, says Alan Feduccia, who reported his work in the Feb. 5 SCIENCE.



Feduccia/SCIENCE

Archaeopteryx' *curved foot claws (left) most closely match those of a perching bird, such as the bowerbird claw (top right, B). The predominantly ground-dwelling lyrebird has straighter claws (top right, A). Feduccia's cartoon (right) rejects the idea of* Archaeopteryx *running after insects.*



Fedducia

The ancient bird at the center of this debate is *Archaeopteryx*, a crow-size creature that lived 150 million years ago and is the oldest known bird. Paleontologists discovered the first *Archaeopteryx* fossil in 1861 and have since unearthed five other specimens. All come from a particular site in southern Germany, where they were preserved in exquisite detail by a fine-grained limestone prized for its use in lithography.

Archaeopteryx has captivated succeeding generations of scientists because the specimens show feathers and other structures not normally preserved in fossils.

Feduccia, an ornithologist at the University of North Carolina at Chapel Hill, began his study by analyzing the claw geometry of nearly 300 modern birds from 30 different species. He found that the degree of claw curvature is a clear indicator of lifestyle: Ground-dwelling species have straighter curved claws, perching birds have moderately curved claws, and birds that climb tree trunks have very curved claws. Almost all modern birds have claws only on their feet.

Comparing *Archaeopteryx'* claws to the modern examples, Feduccia found that the oldest bird did not fit into the ground-dwelling group. Instead, the foot claws of *Archaeopteryx* most closely resemble those of perching birds, while the hand claws of *Archaeopteryx* matched the foot claws of tree-climbing birds.

"I think the evidence is overwhelming that *Archaeopteryx* was an arboreal [tree-dwelling], flying bird. And once you show that, there is a crack in the dam of the entire ground-up theory of avian origins," Feduccia says.

The new work will surely rekindle the smoldering conflict over the origins of birds and flight. Feduccia and many other ornithologists subscribe to the long-standing theory that birds evolved from primitive tree-dwelling reptiles that used feathered limbs to break their fall while leaping from branch to branch.

Many paleontologists, however, support a theory championed 20 years ago by paleontologist John H. Ostrom of Yale University. Ostrom, who identified a previously unrecognized specimen of *Archaeopteryx*, proposed that the early bird had legs, feet, and claws best suited for running along the ground rather than perching. He also observed that *Archaeopteryx* shared substantial anatomical similarities with the small bipedal dinosaurs that lived at the same time during the late Jurassic period.

Putting the two observations together, Ostrom proposed that birds evolved from small theropod dinosaurs that had evolved feathers. Although first used for insulation and for display, the feathers could have gradually helped these running bipeds jump and trap insects.

As paleontologists have solidified the link between birds and theropods, the dinosaurian origin theory has come to dominate its competitor in the scientific journals. Meanwhile, the two opposing camps have entrenched their positions, and the argument has turned personal, with researchers attacking one another in newspaper and magazine articles.

Avoiding the vitriol, Ostrom praises Feduccia's study even though it disproves Ostrom's contention that *Archaeopteryx'* claws were poorly designed for perching. "I think Alan has put together a very solidly based study. I'm not set in concrete," says Ostrom. While he grants that *Archaeopteryx* could probably perch in trees, Ostrom maintains that the bulk of the anatomical evidence indicates *Archaeopteryx* could run well and had evolved from running animals.

— R. Monastersky