as much as a kilometer around. Over the next 250 million years, Benz writes, these objects, known as "planetesimals," collided and combined, forming the nine planets of the solar system.

Benz's own computer model suggests that the moon is the wreckage resulting from a collision between the Earth and a Mars-sized planet. He argues that his collision hypothesis accounts for several mysteries about the moon: Its rocks were left without volatile materials, for example, by the intense heat of collision. And it provides an explanation of the moon's origins that does not require a series of events unique to the moon.

Until recently, Benz notes, scientists were reluctant to accept any theories that invoke catastrophes. Gradualism was the watchword in all fields. But astronomers are now joining biologists and geologists in creating a new understanding of the importance of accidents and catastrophes in the universe.

Mystery Drug

"Aspirin" by Gerald Weissmann, in *Scientific American* (Jan. 1991), 415 Madison Ave., New York, N.Y. 10017.

"There is a bark of an English tree, which I have found by experience to be a powerful astringent, and very efficacious in curing anguish and intermitting disorders," wrote the Reverend Edmund Stone to the president of the British Royal Society in 1763. Although he did not know it, Stone had discovered salicylic acid—better known today as aspirin.

Weissmann, a professor of medicine at New York University, reports that "Americans consume 16,000 tons of aspirin tablets a year—80 million pills—and spend about $2 billion a year for nonprescription painkillers, many of which contain aspirin." We all know that aspirin reduces headaches, soothes sore muscles, brings down fevers, and can even help prevent heart attacks. Less well-known, however, are some of its other uses.

Weissmann notes that aspirin and other salicylates—found in such plants as willow trees, meadowsweet, and wintergreen—can be used to dissolve corns and provoke uric acid loss from the kidneys. They also inhibit the clotting of blood and induce peptic ulcers. "Cell biologists use aspirin and salicylates to inhibit ion transport across cell membranes, to interfere with the activation of white blood cells," he continues, and botanists even use it to induce plants to flower.

A half century after Stone tasted the bitter willow bark, French and German pharmacologists began competing to unlock salicylate's secret. Although at the time the French and English had an edge over the Germans in natural chemistry, by the mid-19th century Germany led the world in synthetic chemistry. In 1874, Friedrich von Heyden established the first factory devoted to the production of synthetic salicylates. In 1898, another German chemist, Felix Hofmann, discovered a much less acidic derivative of the substance, creating aspirin as we know it.

But it was not until the 1970s that scientists began to understand how aspirin works. In 1971, British scientist John R. Vane argued that aspirin inhibits the body's production of prostaglandins, hormones that induce pain and swelling around damaged tissue. Although Vane's "prostaglandin hypothesis" became widely accepted, it has deficiencies. For example, acetaminophen, the most widely used aspirin substitute, works without suppressing prostaglandins at all. And prostaglandins also have important *anti*-inflammatory effects. The hypothesis is dealt a final blow, Weissmann says, by studies of species of ancient marine sponges, which react to aspirin much as humans do, even though they do not produce prostaglandins.

Weissmann says that Vane's hypothesis explains some of aspirin's mysteries, and he has his own idea: Aspirin works partly by interfering with "neutrophils," cells that cause damage when triggered by inflammatory agents. But "much remains to be learned" about this seemingly simple drug, Weissmann concludes. At least it is nice to know, he says, that research into its mysteries has alerted us to the existence of biochemical pathways that we share with the sponges, "creatures from which humans have been separated by a billion years of evolution."

The Human Machine

"A Chip You Can Talk To" by Rachel Nowak, in *Johns Hopkins Magazine* (Dec. 1990), 212 Whitehead Hall, Johns Hopkins Univ., 34th and Charles Streets, Baltimore, Md. 21218.

If scientists at the Johns Hopkins Applied Physics Laboratory have their way, it won't be long before telephones dial numbers on spoken request, tape recorders transcribe conversations directly onto paper, and cars drive themselves. Nowak, a writer for *Bio World*, reports that researchers at the lab are making their first breakthroughs on computer chips that will enable machines to hear and see.

Today's digital and serial computers are ill-equipped to understand language or interpret light signals, Nowak explains. Signals entering a microphone, for example, are "analog." That is, they are recorded in fluctuating voltage levels. But computers can't read analog signals. They must first be converted into a "digital" string of ones and zeros—a clumsy, time-consuming process.

To get around this problem, the team has developed a "basilar membrane" computer chip, which interprets analog signals directly by imitating the human ear and brain. Each of the chip's 30 microscopic filters responds to a particular frequency range and then works with the others to interpret the signals. The researchers hope that all 30 filters soon will be contained on an even smaller chip requiring only a minuscule battery. It will process sound instantly, in "real time." Conceivably, the chip could be connected to the auditory nerve in a deaf person's ear. The ultimate goal, however, is to create a chip that can change sounds into language a computer can understand.

There are many obstacles, Nowak writes. While humans are able to separate meaningful sounds from noise (a humming refrigerator, for example, or droning traffic), computers can't. But researcher Marc Cohen has developed a prototype of a microchip that may be the first step toward a solution. The chip separates blended signals by detecting distinctive frequency patterns and separating them.

Work on chips that "see" is slower going. So far the team has fabricated a three-layer "silicon retina," which, while not as complex as the human eye, can "detect edges, as well as automatically adjust . . . to different light intensities." One such chip, which is one centimeter square, will soon replace a refrigerator-sized computer in a solar observatory in Sacramento.

Eventually, the goal is to link the "seeing" and "hearing" chips through an "associative memory" chip, Nowak notes, so that "the *sight* of an object, say a cup sitting on a table, triggers the *name* of the object."

How long will it be before we can expect a "perceptive computer, obedient to our slightest utterance?" At least 10 years, the researchers predict. The deepest mysteries confronting them do not involve fabricating new microchips but understanding the human organ the chips are supposed to mimic—the brain.

Ants in Bondage

"Slave-making Ants" by Howard Topoff, in *American Scientist* (Nov.–Dec. 1990), P.O. Box 13975, Research Triangle Park, N.C. 27709.

For centuries scientists have been fascinated by the complex social structure of ant colonies. Charles Darwin made detailed studies of ant societies and noted their remarkably efficient division of labor. In recent years, writes Topoff, a psycholo-