possessed the truth, because they all were within what he called "the great unity of Christendom, and Christian morality is everywhere the same."

Tocqueville may or may not have been a believing Roman Catholic, Hinckley says, but "he unequivocally accepted as true the essential Christian teachings, such as the existence of a God, the immortality of the soul, the sacredness of the Gospels, and the rightness of Christian ethics." Tocqueville, however, was plagued by religious doubt, and some scholars have concluded he was a religious skeptic. But Hinckley says his correspondence makes clear that his anguish was not that of "a skeptic trying to believe in God, but [that] of a believer deprived by his Creator of the unwavering certitude that characterizes faith of the highest order."

Tocqueville thought that only a very few men—persons of rare intellect such as Blaise Pascal—"are capable of genuine belief," Hinckley writes. "The rest of humanity has no choice but to accept religious dogma on faith, summoning as much belief as one can for that which one can never know." Most people thus turn to organized religion, which renders "eternal truths . . . intelligible to the crowd." Although it "may not be the highest form of religion," organized religion, "unlike genuine religion, . . . links the many to the divine." Tocqueville's distinction between genuine religion and its lower reflection has been misconstrued by scholars as "a distinction between organized religion and civil (mythical) religion," Hinckley contends. Tocqueville's real message, she says, "is that liberal democracy needs religion, that is, citizens who believe to the extent they are capable of belief."

SCIENCE & TECHNOLOGY

Collision Course

"Accidents of Birth" by Willy Benz, in *The Sciences* (Nov.–Dec. 1990), 2 E. 63rd St., New York, N.Y. 10021.

Scientists hoped that the 1969–72 Apollo moon missions would yield piles of new information about the solar system. And they have. We now know that the moon is some 4.4 billion years old (about the same age as Earth) and that it once had a magnetic field. But the 700 pounds of rocks that astronauts scooped off the moon's surface have provided no answer to a fundamental puzzle, writes Benz, a Harvard astronomer: How was the moon formed?

The relatively small moons orbiting most other planets in the solar system probably are debris left over from the planets' formation, Benz says. But the Earth's moon is too large to be a "leftover." Scientists have speculated that it is, variously, a piece of the Earth's mantle that was flung into orbit long ago; a "companion planet" formed alongside the Earth; or an interplanetary wanderer captured by the Earth.

Each of these theories has major flaws, however. If the moon was a wanderer, for example, how was it forced to settle into orbit? Now, a surprising new consensus is forming about the origins of the moon. It grows out of a new theory of planetary formation called "catastrophism."

Aided by computer models developed by George W. Wetherill of the Carnegie Institution and others, scientists came to realize during the 1980s that the creation of the solar system was much more violent and chaotic than anybody had previously imagined. Some 4.6 billion years ago, Benz writes, a vast cloud of gas and dust rotating around the galaxy became unstable—"perhaps jostled by the shock wave of a nearby supernova"—collapsed under its own weight, and burst out again, forming the sun. The remaining dust and gas circled the young star, much like the rings that now girdle Saturn. The tiny particles stuck together, eventually forming trillions of "rocky conglomerates," many of them 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