From A short history of nearly everything: Bill Bryson
Part IV: A dangerous planet.

Velocity of objects in our solar system is a function of their distance from the Sun. *(Notes go in the space below)*

The chapter begins with a discussion of the development of the theory of the Cretaceous extinction event and the search for the "impact crater". -Clark

The search moved elsewhere. By chance in 1990 one of the searchers, Alan Hildebrand of the University of Arizona, met a reporter from the *Houston Chronicle* who happened to know about a large, unexplained ring formation, 120 miles wide and 30 miles deep, under Mexico's Yucatán Peninsula at Chicxulub, near the city of Progreso, about 600 miles due south of New Orleans. The formation had been found by Pemex, the Mexican oil company, in 1952—the year, coincidentally, that Gene Shoemaker first visited Meteor Crater in Arizona—but the company's geologists had concluded that it was volcanic, in line with the thinking of the day. Hildebrand traveled to the site and decided fairly swiftly that they had their crater. By early 1991 it had been established to nearly everyone's satisfaction that Chicxulub was the impact site.

Still, many people didn't quite grasp what an impact could do. As Stephen Jay Gould recalled in one of his essays: "I remember harboring some strong initial doubts about the efficacy of such an event...[W]hy should an object only six miles across wreak such havoc upon a planet with a diameter of eight thousand miles?"

Conveniently a natural test of the theory arose when the Shoemakers and Levy discovered Comet Shoemaker-Levy 9, which they soon realized was headed for Jupiter. For the first time, humans would be able to witness a cosmic collision—and witness it very well thanks to the new Hubble space telescope. Most astronomers, according to Curtis Peebles, expected little, particularly as the comet was not a coherent sphere but a string of twenty-one fragments. "My sense," wrote one, "is that Jupiter will swallow these comets up without so much as a burp." One week before the impact, *Nature* ran an article, "The Big Fizzle Is Coming," predicting that the impact would constitute nothing more than a meteor shower.

The impacts began on July 16, 1994, went on for a week and were bigger by far than anyone—with the possible exception of Gene Shoemaker—expected. One fragment, known as Nucleus G, struck with the force of about six million megatons—seventy-five times more than all the nuclear weaponry in existence. Nucleus G was only about the size of a small mountain, but it created wounds in the Jovian surface the size of Earth. It was the final blow for critics of the Alvarez theory.

Luis Alvarez never knew of the discovery of the Chicxulub crater or of the Shoemaker-Levy comet, as he died in 1988. Shoemaker also died early. On the third anniversary of the Shoemaker-Levy impact, he and his wife were in the Australian outback, where they went every year to search for impact sites. On a dirt track in the Tanami Desert—normally one of the emptiest places on Earth—they came over a slight rise just as another vehicle was approaching. Shoemaker was killed instantly, his wife injured. Part of his ashes were sent to the Moon aboard the Lunar Prospector spacecraft. The rest were scattered around Meteor Crater.

Anderson and Witzke no longer had the crater that killed the dinosaurs, "but we still had the largest and most perfectly preserved impact crater in the mainland United States," Anderson said. (A little verbal dexterity is required to keep Manson's superlative status. Other craters are larger—notably, Chesapeake Bay, which was recognized as an impact site in 1994—but they are either offshore or deformed.) "Chicxulub is buried under two to three kilometers of limestone and mostly offshore, which makes it difficult to study," Anderson went on, "while Manson is really quite accessible. It's because it is buried that it is actually comparatively pristine."

I asked them how much warning we would receive if a similar hunk of rock was coming toward us today.

"Oh, probably none," said Anderson breezily. "It wouldn't be visible to the naked eye until it warmed up, and that wouldn't happen until it hit the atmosphere, which would be about one second before it hit the Earth. You're talking about something moving many tens of times faster than the fastest bullet. Unless it had been seen by someone with a telescope, and that's by no means a certainty, it would take us completely by surprise."

How hard an impactor hits depends on a lot of variables—angle of entry, velocity and trajectory, whether the collision is head-on or from the side, and the mass and density of the impacting object, among much else—none of which we can know so many millions of years after the fact. But what scientists can do—and Anderson and Witzke have done—is measure the impact site and calculate the amount of energy released. From that they can work out plausible scenarios of what it must have been like—or, more chillingly, would be like if it happened now.

An asteroid or comet traveling at cosmic velocities would enter the Earth's atmosphere at such a speed that the air beneath it couldn't get out of the way and would be compressed, as in a bicycle pump. As anyone who has used such a pump knows, compressed air grows swiftly hot, and the temperature below it would rise to some 60,000 Kelvin, or ten times the surface temperature of the Sun. In this instant of its arrival in our atmosphere, everything in the meteor's path—people, houses, factories, cars—would crinkle and vanish like cellophane in a flame.

One second after entering the atmosphere, the meteorite would slam into the Earth's surface, where the people of Manson had a moment before been going about their business. The meteorite itself would vaporize instantly, but the blast would blow out a thousand cubic kilometers of rock, earth, and superheated gases. Every living thing within 150 miles that hadn't been killed by the heat of entry would now be killed by the blast. Radiating outward at almost the speed of light would be the initial shock wave, sweeping everything before it.

For those outside the zone of immediate devastation, the first inkling of catastrophe would be a flash of blinding light—the brightest ever seen by human eyes—followed an instant to a minute or two later by an apocalyptic sight of unimaginable grandeur: a roiling wall of darkness reaching high into the heavens, filling an entire field of view and traveling at thousands of miles an hour. Its approach would be eerily silent since it would be moving far beyond the speed of sound. Anyone in a tall building in Omaha or Des Moines, say, who chanced to look in the right direction would see a bewildering veil of turmoil followed by instantaneous oblivion.

Within minutes, over an area stretching from Denver to Detroit and encompassing what had once been Chicago, St. Louis, Kansas City, the Twin Cities—the whole of the Midwest, in short—nearly every standing thing would be flattened or on fire, and nearly every living thing would be dead. People up to a thousand miles away would be knocked off their feet and sliced or clobbered by a blizzard of flying projectiles. Beyond a thousand miles the devastation from the blast would gradually diminish.

But that's just the initial shockwave. No one can do more than guess what the associated damage would be, other than that it would be brisk and global. The impact would almost certainly set off a chain of devastating earthquakes. Volcanoes across the globe would begin to rumble and spew. Tsunamis would rise up and head devastatingly for distant shores. Within an hour, a cloud of blackness would cover the planet, and burning rock and other debris would be pelting down everywhere, setting much of the planet ablaze. It has been estimated that at least a billion and a half people would be dead by the end of the first day. The massive disturbances to the ionosphere would knock out communications systems everywhere, so survivors would have no idea what was happening elsewhere or where to turn. It would hardly matter. As one commentator has put it, fleeing would mean "selecting a slow death over a quick one. The death toll would be very little affected by any plausible relocation effort, since Earth's ability to support life would be universally diminished."

The amount of soot and floating ash from the impact and following fires would blot out the sun, certainly for months, possibly for years, disrupting growing cycles. In 2001 researchers at the California Institute of Technology analyzed helium isotopes from sediments left from the later KT impact and concluded that it affected Earth's climate for about ten thousand years. This was actually used as evidence to support the notion that the extinction of dinosaurs was swift and emphatic—and so it was in geological terms. We can only guess how well, or whether, humanity would cope with such an event.

And in all likelihood, remember, this would come without warning, out of a clear sky.

But let's assume we did see the object coming. What would we do? Everyone assumes we would send up a nuclear warhead and blast it to smithereens. The idea has some problems, however. First, as John S. Lewis notes, our missiles are not designed for space work. They haven't the oomph to escape Earth's gravity and, even if they did, there are no mechanisms to guide them across tens of millions of miles of space. Still less could we send up a shipload of space cowboys to do the job for us, as in the movie *Armageddon*; we no longer possess a rocket powerful enough to send humans even as far as the Moon. The last rocket that could, *Saturn 5*, was retired years ago and has never been replaced. Nor could we quickly build a new one because, amazingly, the plans for Saturn launchers were destroyed as part of a NASA housecleaning exercise.

Even if we did manage somehow to get a warhead to the asteroid and blasted it to pieces, the chances are that we would simply turn it into a string of rocks that would slam into us one after the other in the manner of Comet Shoemaker-Levy on Jupiter—but with the difference that now the rocks would be intensely radioactive. Tom Gehrels, an asteroid hunter at the University of Arizona, thinks that even a year's warning would probably be insufficient to take appropriate action. The greater likelihood, however, is that we wouldn't see any object—even a comet—until it was about six months away, which would be much too late. Shoemaker-Levy 9 had been orbiting Jupiter in a fairly conspicuous manner since 1929, but it took over half a century before anyone noticed.

Interestingly, because these things are so difficult to compute and must incorporate such a significant margin of error, even if we knew an object was heading our way we wouldn't know until nearly the end—the last couple of weeks anyway—whether collision was certain. For most of the time of the object's approach we would exist in a kind of cone of uncertainty. It would certainly be the most interesting few months in the history of the world. And imagine the party if it passed safely.