# 16 MEDIA/*METEŌRA*

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## **A Fireball Falls**

Minutes after sunrise on February 15, 2013, an intensely bright meteor, or superbolide, traveling at 19 kilometers per second (about 42,500 miles per hour), exploded over Chelyabinsk Oblast, Russia. Trailing white smoke and shedding molten debris as it flashed across the morning sky, the interplanetary intruder—an asteroid originating from the main belt between Mars and Jupiter—burst at 27 kilometers (nearly 17 miles) altitude with the force of 500 kilotons of TNT (see Figures 16.1 and 16.2). The resultant shockwave damaged more than 7,300 buildings over a wide radius. Together, the airburst and shockwave drove some 1,600 unlucky persons to seek medical treatment for their injuries, which included ultraviolet burns, eye pain and temporary blindness, and cuts and



Figure 16.1 Photo Credit: NASA



Figure 16.2 Photo Credit: NASA

bruises caused by the shattering of glass windows. In modern recorded history, only the Tunguska meteor, which felled approximately 80 million trees over 2,150 square kilometers (830 square miles) in the East Siberian taiga, in June of 1908, detonated with more destructive force.<sup>1</sup>

From the ground, the shooting star was witnessed by thousands and recorded by hundreds of citizens and commuters. Within hours, YouTube, VKontakte, and other video-sharing websites and platforms were circulating sounds and images of the impactor and its consequences, captured incidentally or opportunistically by handheld smartphones, dashboard-mounted cameras, and closed-circuit traffic and security cameras (see Borovička et al., "A Catalog" A90; see Figure 16.3). Online news sources and blogs, as well as traditional print and electronic media, featured various of these casual digital recordings in their coverage of the event ("casual" in multiple senses: accidental, occasional, informal, unplanned). Moreover, several YouTube users compiled, edited, and remixed the images, in some cases adding a drama-heightening musical soundtrack. Shot steadily or shakily, from fixed points or moving vehicles, many of the videos show the meteor hurling incandescently across the heavens, the arc of its billowing plumes cleaving the unclouded sky. Others register not



Figure 16.3 Photo Credit: Wikimedia Commons

the falling fireball but, instead, its transitory terrestrial illuminations, the eerie spectacle of its landscape-bleaching searchlight. Still others document the shockwave and sonic boom, their violent percussions and repercussions: the tremendous blast and roar, the blown-in windows and doors, the squalling of car alarms, the sudden fright and commotion (in the streets, in workplaces, in classrooms).

Popular-media users and sharers were not the only ones fascinated by the accidental technological capture of the fiery atmospheric phenomenon; amateur and professional astronomers, too, doubtless felt a certain frisson upon beholding the serendipitous work of the cameras. For, as if marvelously, those humble cameras, some of them equipped with microphones, happened to preserve not only a rarely seen or heard cosmic occurrence but an entirely unanticipated one, rendered from multiple viewpoints, no less. The asteroid's unexpected appearance prompted numerous scientific and security-related questions, and the haphazardly generated recordings were understood to contain a huge amount of information about what actually happened. As these visual and audiovisual texts were, by institutions and independent researchers around the world, invested with evidential authority and epistemic significance, so the untimely meteor was reclaimed as an object of media-forensic examination and reconstruction.

Within a week, a pair of investigators from the Institute of Physics at the University of Antioquia in Medellín, Colombia, "using evidence gathered by one camera at the Revolution Square in the city of Chelyabinsk and other videos recorded by witnesses in the close city of Korkino," presented "a preliminary reconstruction" of the meteor's orbit and trajectory. In their unrefereed report, the authors, Jorge Zuluaga and Ignacio Ferrín, forthrightly acknowledge the blogger and "citizen astronomer" Stefan Geens, founder of Ogle Earth, from whom they borrowed "method and images" ("Preliminary Reconstruction"). Shortly thereafter, Zuluaga, Ferrín, and Geens teamed up to produce a revised preprint, titled "The Orbit of the Chelyabinsk Event Impactor as Reconstructed from Amateur and Public Footage." To obtain their calculations, the trio undertook a frame-byframe analysis of four YouTube videos, selected on the basis of their comparatively "high quality" and precisely known locations of origination, so as to measure "the shadows cast by objects in the scene." Additional crucial data-"the azimuths of reference directions," the "distances and sizes of the familiar objects in the footage"-were gathered from Google Earth and "some archived images of the places used in the triangulation" (Zuluaga et al.). In November of 2013, astronomers and planetary scientists from the Czech Republic Academy of Sciences, the University of Western Ontario, the Russian Academy of Sciences, the SETI Institute, and the NASA Ames Research Center published detailed studies in the journals Science and Nature, in which dozens of publicly available videos and projections were appropriated, calibrated, "corrected," synchronized, optically and acoustically analyzed, and, finally, stabilized as scientific evidence (Borovička et al., "The Trajectory"; Brown et al.; Popova et al.). The New Yorker magazine praised these "ingenious" footageinspecting scientists for their "feat of clever detective work" (Scharf).

History, ever obedient to a strict chronology, tells us that the Chelyabinsk meteor chanced to fall but once. Fortunately or not, the mediatized meteors that have propagated in its wake appear destined to befall us indefinitely. The same technopolitical devices and apparatuses of risk and surveillance, the same media-cultural habits and practices of attention, consumption, observation, communication, exhibition, participation that enabled the recording and post-hoc scrutiny of the space rock ensure the endless dissemination of its reproductions. The singularity that suddenly fell to Earth now belatedly circles the globe in countless graphic and electronic iterations. The onetime meteor and its timeless, all-the-time mediatization: at once a fortuitous coincidence and an inevitable constellation. Media/meteor: each the other's casualty and condition of close *encounter*, their reciprocal modalities and mutual interferences structuring the impactor's deliverance and status as a mass *event*. "Would an event that can be anticipated and therefore apprehended and comprehended, or one without an element of absolute encounter, actually be an event in the full sense of the word?" asks Jacques Derrida in "My Chances/*Mes Chances.*"

We are not supposed to see it coming. If what comes and then stands out horizontally on a horizon can be anticipated then there is no pure event. No horizon, then, for the event or encounter, but only verticality and the unforeseeable.

(6)

On that fateful morning in 2013, nobody saw the asteroid coming. Having since arrived, it arrives still. In one form or another, its representation continues to be used, viewed, studied, reworked, recirculated; it is seeable and reseeable on demand the world over. Yet, fundamentally, meteoric phenomena remain as unforeseeable as ever. In his essay, Derrida does not speak of the *media* event or of the *mediatized* encounter. He does not concern himself with the contemporary *media/meteor complex*. It falls to us to coin it and to consider its operations. As we shall see, such a complex, while integral to its earthly reckoning and reception, only ever fleetingly apprehends (and never truly comprehends) the meteor's thrownness, its deviating downward motion, its declination. Though it brings meteors determinately within the horizon of our social, institutional, and technological perceptibilities and capabilities, it fails to flatten their unpredictable inclinations, to permanently ground their precipitous movements and mutations. Pitched between an atmospherics of turbulent chance and a politics of vigilant necessity, the media/meteor complex, even as it articulates the verticality and inadvertency of the meteor's eventness, reveals and perpetually reproduces the elemental mediacy of its encounterability.

### Time of Meteora

"In the beginning are the meteors," Michel Serres proclaims, aptly enough, in his book *Genesis* (101). Rather than at the beginning of *Genesis*, as might be expected, however, the statement comes *in medias res*, about 100 pages in (in the English edition). While this mediate placement might at first seem less than fitting, it is really all the more so. For, as it happens, the realm of the meteoric is a kind of middle corridor, a region of intercedence, liminal, transitional, neither on the ground nor over the moon. "Our science, our mechanics, generally takes place, from Newton to Auguste Comte, on earth and in the heavens, the fall of bodies and the orbit of stars. Almost never in between" (85). So writes Serres in *The Birth of Physics*, meditating on the sixth book of Lucretius's *On the Nature of Things*, the section of the ancient poem that treats of meteorological happenings, or, as Serres prefers, of "*meteora*." Seeking to recover, for the history and philosophy of science, elements of the long-discarded tradition of atomist physics as developed, in turn, by Leucippus, Democritus, Epicurus, and Lucretius, Serres laments that modern scientific reason, in excluding the sphere of *meteora*, in banishing the "middle ground between mechanics and astronomy," has rendered an "immense" swath of the natural world practically "incomprehensible" (85–86).

By "meteora," crucially, Serres has in mind not climatic constancies but, on the contrary, thunder, lightning, "clouds, rain and waterspouts, hailstorms or showers, the direction and force of the wind, here and now." Insistently, he continues: "And I don't mean the prevailing wind. Meteors are accidents, occurrences. A chance proximity, an adventitious environment of the essential" (*Birth of Physics* 67). Daniel Tiffany translates the latter part of this same passage a bit differently: "Meteors are accidents, events: a hazardous milieu, the factual environment of essences" (103). Not what persists diffusedly in the background but what is thrown suddenly and perilously into the middle ("milieu") of the present moment; not the unchanging laws that make possible the steady climate but a fact or advent that makes palpable a freakish weather: such, following Serres following Lucretius, is the nature of meteoric things. Returning to *Genesis*, then, there is warrant to rephrase its heterodox proclamation thus: *In the beginning are the chance happenings, the accidental things*. And: *In the beginning are the media, the mediate things*. And, weirdly but inescapably: *The beginning is the accidental middle of things*.

Serres's philosophy of *meteora* conjures the old, forgotten meanings of *meteor* and *meteorology*, reviving and reuniting them after an epic hiatus. According to the *Journal of the International Meteor Organization*,

the word "meteor" is derived from the Latin *meteorum*, from the Greek *meteoron*, in its plural form meaning atmospheric phenomena or anything in the heavens. It is the substantive use of the Greek *meteoros*, which means "raised," "lofty," or in a more figurative sense, "sublime."

(McBeath 35)

Under the modern episteme, meteors are restricted in their belonging to astronomy, the study of the stars, but, in classical antiquity, they—and many other "sublime" occurrences besides—belonged to a varied and expansive meteorology. "When we look at the ancient Greek and Roman texts on meteorology, we discover discussions about 'lofty' things which today would be regarded as astronomical phenomena, such as comets and the Milky Way," Liba Taub explains. "However, earth-quakes and other phenomena that would today be regarded as geological and seismological were also treated [therein]. And, as we would expect from our modern term, much of ancient meteorology too was concerned with weather" (2).

In the *Meteorology*, to take the supreme instance, Aristotle describes the scope of his inquiry as "everything which happens naturally, but with a regularity less than that of the primary element of bodies, in the region which borders most nearly on the movements of the stars" (qtd. in Taub 77). For Aristotle, meteorology does not deal with the orderly perfection of the superlunary—the eternal circular motions of the stars and planets are handled in a separate treatise, *On the Heavens*— but, rather, with how those remote celestial motions interact unpredictably with the terrestrial elements (earth, air, fire, and water) to cause natural sublunary happenings. It studies the stochastic stirrings and sudden precipitates of immutable and mutable processes, the random generations and corruptions resulting from the agitated intermixture of "lofty" and lowly entities. "Within [Aristo-tle's] hierarchical treatment of nature," Taub observes, "meteorology is in the middle. This central position reflects the mediating role that meteorological processes serve" (77). Meteors, on this classical view, are all those "weather" accidents (shooting stars, comets, the Milky Way, mists, clouds, rain, snow, hail, winds of various kinds, earthquakes, thunder, lightning, rainbows, halos) that manifest and mediate the unstable, somewhat irregular exchanges between earth and firmament, between, as Serres puts it, "the fall of bodies and the orbit of stars."

In the beginning are the meteors. Along with the allusive substitution of "meteors" for "Logos" comes the new (old pagan) grammar and cosmogony: lowercase plural instead of capital singular, present tense instead of past, ongoing chance emergence rather than divine creationary speech-act. Already in the middle at the beginning, "here and now" from the start, meteora, for Serres, are mediators of an exceptional temporality, couriers of an infinite commotion and multiplicity, "chaos-cloud" messengers (Birth of Physics 86). In their radical indeterminacy, they "dramatise the fundamental variable of physics": the Lucretian *clinamen*, the atomic swerve or declination, bringer of turbulence and "creator of time *contretemps*" (87; italics in the original).<sup>2</sup> Theirs is the time—the counter-time, the time of mishap and misfortune, time out of time-that modern science, with its devotion to "exact determination or rigorous over-determination" and its preoccupation "with absolute control" and "mastery without vacillation or the ambiguity of margins," has, as a rule, refused to recognize (67). This imperious refusal, "this repression," according to Serres, is embodied in the architecture and institution of the laboratory and, by extension, of the astronomical observatory: a refuge with walls and a roof, an enclosure insulated "against turbulence," protected from inclement weather, from the time of always untimely meteora. "Science is shut inside" (67-68). Meteors, by contrast, run their deviating course outdoors, come into being (and are soon undone) in "the place of disorder and the unforeseeable, of local danger, of the formless" (67).

Following Serres's claim that "the time of *meteōra* does not match up with the time of history," Jan Golinski argues that, whereas ancient meteorology had subsumed meteors within "an understanding of time as *kairos* (a discontinuous set of significant sacred events)," the meteorological sciences since the eighteenth century have tried to shackle atmospheric phenomena to "a (continuous, secular) *chronos*" (67, 78). In defiance of—and because of—its contingency, its unpredictability, its hazardous amorphousness, the weather has been disciplined and adjusted to fit "a homogeneous scale of time measurement" (Golinski 78). Meteors ("extraordinary appearances in the air") have been abstracted and subjected to the normalizing dictates of "the clock and calendar," reduced to "the regular and the repeatable"; formerly signs, marvels, and portents, they are now seconds, minutes, and standard calendrical units (78).<sup>3</sup> Arden Reed, in *Romantic Weather*, expands on Serres's provocative contention, asserting that

the temporality of the weather must not be confused with clock time, for there is nothing measured in the movement of a "meteor," as in that of a star. And the aleatory or erratic alterations of any one "meteor" are contingent on any number of other "meteors," themselves contingent, and propagate only more accidents in their wake.

(11)

Implicit in Reed's astute reading of Serres's new (old) meteorology is the notion that the project of temporal rationalization is never fully realized or finished. Though impelled by an equalizing imperative, the chronometric system is never perfected to the point where its constituent moments— every "tick," every "tock"—are uniformly pure, transparent, or even determinable. Now and again, something interrupts the process of meteoric time's domestication and desacralization. Something from somewhere sometimes intrudes and obscures. That something? *Meteōra* themselves, naturally. "What good does it do me to know the exact second of the next eclipse when a thick mounting wind keeps me from seeing it?" Serres wonders. "What good are all the tools in the world when snow and mud prevent their use?" (*Birth of Physics* 68). For centuries, meteorology has scrupulously recorded and measured and strived to predict. Yet its forecasts are often defective. Meteors *interfere*. Born of blind chaos, allied with aleatory mediation, they forever threaten to bring the storms, hamper the instruments, muddy the waters, cloud the view.

#### **Could It Happen Here on Earth?**

As meteors occasionally do, the Chelyabinsk impactor caught astronomers completely unawares. However, the asteroid called 367943 Duende, also known as 2012 DA14, which, in an odd coincidence, passed close to the Earth a mere 16 hours later, did not surprise. Indeed, scientists at NASA's Near-Earth Object Observations Program had been tracking Duende—so named for the elfin or goblinish creature of Iberian and Latin-American legend—since its discovery by researchers at the Astronomical Observatory of Mallorca, Spain, in February of 2012. Duende transited at a distance of roughly 27,700 kilometers (17,200 miles)—closer to the Earth's surface than weather and communication satellites in geosynchronous orbit. Astronomers confidently (and rightly) calculated that this particular space rock would "fly by," rather than collide with, the Earth (see Durda; NASA, "Russia Meteor"; Yeomans and Chodas). But what about all the other wayward rocks hurtling through the solar system? The mission of the NASA division charged with monitoring Duende and other near-Earth objects, or NEOs, attests to the accepted statistical certainty that, in the indefinite future, some number of interplanetary "goblins" will not pass so uneventfully or so inconsequentially. Some are sure to swerve.

The basic plan for the NEO Observations Program was laid out in a couple of congressionally requested NASA reports issued in 1992. The first of these, *The Spaceguard Survey*, explained that impacts caused by

Earth-approaching asteroids and comets pose a significant hazard to life and property. Although the annual probability of the Earth being struck by a large asteroid or comet is extremely small, the consequences of such a collision are so catastrophic that it is prudent to assess the nature of the threat and to prepare to deal with it. The first step in any program for the prevention or mitigation of impact catastrophes must involve a comprehensive search for Earth-crossing asteroids and comets and a detailed analysis of their orbits.

(v)

The report went on to call for the construction of a globe-spanning assemblage of technoscientific media, "a coordinated international network of specialized ground-based telescopes"—in conjunction with "large planetary radars," "rapid international electronic communications," and "a database of discovered objects"—that would enable astronomers to detect, confirm, continuously observe, and share and store information about potential Earth-impacting asteroids and comets larger than one kilometer in diameter (v–vi). The requisite resource allocations and expenditures, the report concluded, "can be thought of as a modest investment to provide insurance for our planet against the ultimate catastrophe" (vi).

The Spaceguard Survey, notwithstanding its sly titular reference to a plot element in Arthur C. Clarke's science fiction novel *Rendezvous with Rama*, sought to bolster its case by highlighting the proposed program's congruence with the latest scientific findings and theories, including the "Alvarez hypothesis." In a landmark article for Science published in 1980, the physicist Luis Alvarez and his son, the geologist Walter Alvarez, together with the chemists Frank Asaro and Helen Michel, propounded the view that the mass extinction marking the end of the Cretaceous Period, which extinction included that of the dinosaurs, was precipitated by an enormous bolide impact. While the Alvarezes and company were not the first scientists to think seriously about Earthcolliding bodies (The Spaceguard Survey traces the idea to Fletcher Watson's Between the Planets and Ralph Baldwin's The Face of the Moon, both dating from the 1940s), their hypothesis was well supported by newly discovered geochemical evidence involving the concentration of iridium in sedimentary rocks. One year later, a pathbreaking meeting and workshop, held in Snowmass, Colorado, and directed by NASA's Jet Propulsion Laboratory, asked participants to consider how, and to what extent, a major asteroid or comet impact might disrupt or destabilize human life and society. What were the biggest risks? Would agricultural and economic systems break down? Would social and political institutions fail? Would pandemonium ensue? Would civilization itself collapse? Also, how might an asteroidal or cometary disaster be averted or mitigated in the first place? The workshop's main conclusions were summarized and disseminated, in 1989, in the final chapter of Cosmic Catastrophes, a popular-science book written by Clark Chapman and David Morrison, a pair of leading NEO researchers.

Already on the rise, then, by the early 1990s, worries about dangerous meteors were amplified in July of 1994, when Comet Shoemaker–Levy 9 crashed into Jupiter. An extraterrestrial collision of two solar-system bodies had never theretofore been observed in "real time." The news media, no doubt enticed by the promise of violent celestial spectacle, made the most of the extraordinary occasion. *Time* magazine's focus and slant were typical. The cover of its May 23, 1994 issue featured a vividly illustrated depiction of the fragmentary comet's approach and fiery impact, complete with the headline "COSMIC CRASH—A shattered comet is about to hit Jupiter, creating the biggest explosion ever witnessed in the solar system. Could it happen here on Earth? Yes …" For weeks before, during, and after the event, quotable and broadcast-suitable experts were in high demand. The Canadian astronomer David Levy, who co-discovered the comet, estimated that, during the first three weeks of July alone, he gave some 125 press interviews (133). The entertainment industry also capitalized on the "Could it happen here?" question. In his study of representations of meteors, comets, and asteroids in popular cinema and television, William Hartwell notes that the number of productions emphasizing "the hazards of potential cosmic impactors" increased sharply in the decade following the Shoemaker–Levy 9 event (82). "Media publicity during the impact of Shoemaker–Levy 9, and especially the resultant worldwide distribution of Hollywood blockbuster films such as *Armageddon* and *Deep Impact*"—both of which were released in 1998, the same year NASA launched the NEO Observations Program—"have arguably produced a greater public awareness and support for this issue than almost any but the most targeted and costly public educational campaigns could have accomplished" (83–84).

#### Scaling the Risk

Astronomers and planetary scientists, nevertheless, had their own notions about how to raise public awareness and urge attention to their findings. At the inaugural United Nations International Conference on Near-Earth Objects, held in New York City, in April of 1995, Richard Binzel of the Massachusetts Institute of Technology recommended the adoption of an index system, devised by him, to facilitate "simple and efficient communication between astronomers and the public" concerning NEO-impact hazards ("Near-Earth Object Hazard Index" 545). Four years later, a revised version of his system won official endorsement from the sponsors and attendees of the International Monitoring Programs for Asteroid and Comet Threat (IMPACT) workshop in Torino, Italy, and from NASA and the International Astronomical Union. The Torino Impact Hazard Scale, as it was now designated, or "Torino Scale" for short, offered itself as an objectively rational, socially beneficial, easily understandable, civically responsible instrument of risk communication.

The direst hazards associated with near-Earth objects tend to be regarded by astronomers as extraordinary in two senses: they are extraordinarily unlikely and, because of their consequences, extraordinarily dreadful to contemplate. Infrequent but extreme, they lie outside the pattern or bounds of the everyday and, simultaneously, at the peak intensity of feeling and experience. For Binzel and fellow scientists wishing to spread the warning word, this dual aspect held important implications for the Torino Scale's graphic and informational design. As a vehicle for the popular communication of the doubly extraordinary, the scale, to be effective, needed to be affectively and psychologically attuned as well as intelligible and scientifically credible. Its task was to bring the NEO threat, in its astounding beyondness, to public consciousness in a manner devoid of exaggeration and purged of raw emotion. The infographic aimed to alert, educate, and motivate the masses without overexciting them. "Because collisions of asteroids and comets with the Earth represent a topic so provocative and so prone to sensationalism," Binzel wrote in a paper for *Planetary and Space Science* published in 2000,

great care must be taken to assess and publicly communicate the realistic hazard (or non hazard) posed by such events. At the heart of this risk communication challenge resides the fact that low probability/high consequence events are by their very nature not within the realm of common human experience.

("Torino Impact" 297)

Updated in 2004 and still in use today, the Torino Scale employs various strategies to evaluate and classify the risk of meteoric catastrophe (see Figure 16.4).<sup>4</sup> Familiar textual, numeric, and symbolic conventions are arranged so as to assimilate the alien peculiarities of impact hazard—very improbable, vastly consequential—to allegedly common experience. Color-coded zones, succinct verbal descriptions, and consecutive integers ranging from zero (at the top) to ten (at the bottom) are neatly stacked within an internally segmented rectangle. The greater the assessed risk, the higher the assigned numeral, with zero indicating maximal unlikelihood of collision. Each numeral is accompanied by a small block of elucidative prose, "a few sentences of qualitative explanation" (Binzel, "Torino Impact" 302). A simple five-color scheme further defines and categorizes the

# THE TORINO SCALE Assessing Asteroid/Comet Impact Predictions

No Hazard	0	The likelihood of collision is zero, or is so low as to be effectively zero. Also applies to small objects such as meteors and bolides that burn up in the atmosphere as well as infrequent meteorite falls that rarely cause damage.
Normal	1	A routine discovery in which a pass near the Earth is predicted that poses no unusual level of danger. Current calculations show the chance of collision is extremely unlikely with no cause for public attention or public concern. New telescopic observations very likely will lead to re-assignment to Level 0.
Meriting Attention by Astronomers	2	A discovery, which may become routine with expanded searches, of an object making a somewhat close but not highly unusual pass near the Earth. While meriting attention by astronomers, there is no cause for public attention or public concern as an actual collision is very unlikely. New telescopic observations very likely will lead to re-assignment to Level 0.
	3	A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of localized destruction. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by the public and by public officials is merited if the encounter is less than a decade away.
	4	A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of regional devastation. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by the public and by public officials is merited if the encounter is less than a decade away.
Threatening	5	A close encounter posing a serious, but still uncertain threat of regional devastation. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than a decade away, governmental contingency planning may be warranted.
	6	A close encounter by a large object posing a serious, but still uncertain threat of a global catastrophe. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than three decades away, governmental contingency planning may be warranted.
	7	A very close encounter by a large object, which if occurring this century, poses an unprecedented but still uncertain threat of a global catastrophe. For such a threat in this century, international contingency planning is warranted, especially to determine urgently and conclusively whether or not a collision will occur.
Certain Collisions	8	A collision is certain, capable of causing localized destruction for an impact over land or possibly a tsunami if close offshore. Such events occur on average between once per 50 years and once per several 1000 years.
	9	A collision is certain, capable of causing unprecedented regional devastation for a land impact or the threat of a major tsunami for an ocean impact. Such events occur on average between once per 10,000 years and once per 100,000 years.
	10	A collision is certain, capable of causing a global climatic catastrophe that may threaten the future of civilization as we know it, whether impacting land or ocean. Such events occur on average once per 100,000 years, or less often.

Figure 16.4 Photo Credit: NASA

level of risk: white represents "no hazard"; green, "normal"; yellow, "meriting attention by astronomers"; orange, "threatening"; and red, "certain collisions."<sup>5</sup> According to Binzel, the multidimensionality of the knowledge–problem caused by close-approaching space rocks is reflected in the scale's attempt to harmoniously "translate" disparate kinds of information, chief among them "the impact probability of the object" and "the potential consequences should an impact occur" (298). Overall, the scale's organization of line, language, number, and color, its visual logic and grammar, is meant to "provide a context for understanding the full range of the potential hazard" (298).

Probability and explosive energy. Collision likelihood and destructive magnitude. Superlunary reckoning and sublunary devastation. Stochastics and impact kinetics. Chance and catastrophe. These form the Torino Scale's discursive warp and woof, the terms and parameters of its calculative rationality and the repertoire of its scientific imaginary, its physics and its metaphysics. Within its horizon, astronomical rarity and world-ending calamity, sublime visions of exception and excess,

are coded, coupled, and figured, "translated," put into speculative relation, thought together. The slightest chance, the slimmest odds, on the one hand, and a future of total disaster, of civilizational ruin, on the other—each such eventuality a limit case of the fathomable—are coordinated in, and mediated through, the scale's rhetorics and aesthetics. NEO science's conception of its most broadly significant postulates, and of its most universally pressing conclusions, is schematized for all to see, reduced to a risk-assessment formula, analyzed into (and vernacularized as) something of an odds sheet, a tool for gaining advantage in a cosmic game of chance. Multiple orders of occurrence—celestial, temporal, geospatial, physical—are evoked and entwined. The vital importance of proper mass-psychological preparedness is assumed and implied throughout. Attitudes of attention, concern, and relative unconcern are differentially prescribed as a function of current—and continually revisable—computations and appraisals, including those involving the status of scientific certainty itself with respect to any given Earth-approaching object. "Serious" is distinguished from "normal," "unprecedented" from "routine." Ignorable ambient conditions (the realm of the mundane climatic, in Serres's idiom) are opposed to high-threat situations warranting "international contingency planning" (the realm of the accidental meteoric).<sup>6</sup>

The NASA astronomer Donald Yeomans, in Near-Earth Objects: Finding Them Before They Find Us, observes that the Earth is constantly "pummeled" by interplanetary dust and particles—more than 100 tons a day—but most such debris is harmless, burning up in the atmosphere (109). To this nominally hazardless status quo the Torino Scale assigns a zero value and a blank white background. Zero and white, marks of unmarkedness, signifiers of emptiness, homogeneity, indifference, neutrality, serve here as emblems of ordinary uneventfulness in all its drab nullity-in other words, in all its ideal *purity*, for days without meteors are precisely days without stain or happenstance. A temporality untouched by meteora is a temporality free of taint ("touched by color," etymologically) and of contamination ("touched by contingency"): a strict time, an immaculate time, an undeviating time, a contra-contretemps time. At the other end of the scale, shading the lowermost blocks of the rectangle, red screams danger, as symbolically it so often does (Heat! Fire! Hell! Rage! Passion! Power! Blood!). In between, from top to bottom: green, yellow, and orange. Thus, sliding down the scale, moving from crown to foot, "warmer" hues replace "cooler" ones. If it seems natural that the higher integers should correspond to the gravest threats, and those latter to the color connoting violent intensity and extreme peril, then the easy cooperation of these numeric and chromatic codes is disturbed, perhaps, by the principle regulating the figure's vertical relations. Why descend to number ten? Why do rising numbers not rise? And why red at the base? Why make the expression of alarm fundamental? Hot air expands, flames ascend, blood boils, passions overflow, mercury climbs with fever. Why confuse the message, or undercut its urgency, by contradicting the logic of the thermometer, that ready-made sign? In short, why scale down when things heat up?

If the Torino Scale's curiously inverse or contrary thermometry appears to have escaped notice or comment, other of its design features have not gone unremarked. For instance, Binzel himself acknowledged the scale's lack of functional independence, stressing that "responsible risk communication of asteroid and comet close encounters *requires* the inseparable reporting of both the encounter date and its hazard scale value" ("Torino Impact" 298; italics in the original). The scale's non-presentation of encounter information has decisive semantic and practical implications, as this conspicuous absence constitutes the hole that centers the whole structure, that consigns its value and utility to a time ungiven, unspecified, to a crucial contextual *elsewhen*. Without its institutional companion, namely, the news-media tradition of timely reportage, Binzel's device is useless and all but meaningless. Then again, in this very deficiency lies the Torino Scale's quantum of perennial wisdom. The time of *meteora* precipitates the moment of rupture. Never indubitable in advance, meteors, like tornadoes and tempests, are always "breaking news."

Other infelicities and lacunas trouble the infographic as well. "Concerns among professional astronomers are that the 0 to 10 point system is too simple and compresses too many important

details into a single number," admits Binzel in a piece co-written with *Cosmic Catastrophes* authors Chapman and Morrison. Such "details are sacrificed for the sake of simple communication of the central message. What's more, there is no mathematically unique (or quantifiably best) solution" to the conundrum. "It depends on values and judgments. Thus any one-dimensional scale is demonstrably flawed" (Morrison et al. 359). Scientific semiosis, it turns out, is a treacherous business, imperfectly rational and disconcertingly normative. Some (immeasurable) measure of meaning is irretrievably lost in the (sacred) exchange—this is the "sacrifice"—and, moreover, discretion must forever be exercised in the face of indeterminacy. Inevitably, even the most "responsible" risk communication takes place in and across the chasm between scientific knowledge and public comprehension, each domain further possessing its own faults and fissures, not all of them recognized or recognizable, much less "demonstrable."

It is noteworthy, in this connection, that the Torino Scale's text confesses certain gaps and ambiguities, as when it states, which it several times does, that "new telescopic observations will lead to [rank or category] re-assignment," or when it stipulates (again, repeatedly) that the extent of a designated threat is "still uncertain."<sup>7</sup> Yet these little confessions conceal as much as they reveal. They avow some degree of uncertainty the better to mask and manage the entirety of it. The provisionality, the limited currency, the *contingency* of NEO-scientific knowledge is at once registered and reassured by the promise of more and better data to come. Yes, estimates and predictions will need amending in the light of new information, and it is true that the value assigned to a hazard today might necessitate its revaluation tomorrow. Nevertheless, the scale's foundation is sound and its authority reliable. Reclassification happens, but the basic taxonomy is trustworthy. Impact risks are always partly known and partly unknown, but they are never wholly unknowable (this maxim being merely a particularization of risk discourse's originary truism). By means of this rhetorical autoinoculation, the contagion of indeterminacy is ostensibly contained.<sup>8</sup>

The scale's distinctive way of managing uncertainty condenses and recapitulates the more general technique. Writing in Nature, in 1994, Chapman and Morrison discussed a number irreducible uncertainties intrinsic to NEO-scientific endeavor. Nobody really knows what is "the threshold impact energy for global catastrophe," they said. No sure method exists for ascertaining "the environmental consequences of impact" or "the effects on human civilization" (35). Complexities abound. Much depends on whether the object is an asteroid or a comet; on its diameter, density, and composition; on its velocity and angle of incidence; on whether it strikes land or sea; whether forest, desert, grassland, or tundra, or ocean, lake, or river; whether in the northern hemisphere or the southern; whether in winter, spring, summer, or autumn; and so on. Confronted with this welter of indeterminacies, Chapman and Morrison produced an elaborate statistical analysis that subtly elided or displaced many of its assumptions, rationalized its many conjectures and approximations, and, above all, controlled and legitimated its relation to nescience. As Felicity Mellor has argued, "Rather than a set of contestable assumptions and unknowns, non-knowing became an ordered quantity which can be bounded and subjected to numerical analysis" ("Negotiating Uncertainty" 19). Unwilling to accept (much less authorize) a chaos of indeterminate possibilities, the NEO researchers, in a move equally paradigmatic and programmatic, articulated the standard logic of risk to establish a positive system of "certain probabilities" and "known uncertainties" (23, 19).

The Torino Scale aims to popularize this positive system. But just how *positive* is Binzel's mediating construct? How positive can it be? After all, the infographic is static, but the meteor *moves*. The former stands as an inscribed monument, a fixed archive, epistemically restricted, unresponsive, and heavy, petroglyphic: the scale "knows" what it knows and nothing more, eternally. The latter, meanwhile, maintains a very different relation to time, space, materiality, and the possibility of knowledge: the space rock, now here, now there, now like this, now like that, is epistemically unstable, protean, liable to *perturbation* (in astronomical parlance); a thing confoundingly in flux, speeding, tumbling, shifting, transforming; its size, substance, and trajectory—its "true nature"—in doubt from one moment to the next, the subject of unremitting invigilation and painstaking calculation and recalculation. A technical nomenclature is deployed to make sense of these perturbing semi-obscurities, to sort out these elusive mobilities, vectors, variabilities, mutations. Perhaps at first only a faint and distant *apparition* (that wonderfully resonant astronomical term), the approaching comet or *minor planet* (another name for "asteroid") acquires shape and significance as estimates improve and data accumulate over time. If, by chance—because by what else?—it enters the Earth's atmosphere and vaporizes luminously, the rocky body becomes a meteor proper, a shooting star, a falling star, maybe a fireball or a bolide or even a Chelyabinsk-type superbolide, depending on how bright it flashes and whether it bursts in the air. If it hits the ground, it is, finally, a meteorite, an impactor, or, as it used to be known before it was severed from the weather, a "thunderstone."<sup>9</sup> In the doomsday scenario—the so-called worst case, the furthest projection of NEO science's apocalyptic imagination, the hallucinatory drama of its eschatology—the striking meteor causes a veritable worldwide disaster (*disaster*: literally, an ill-starred event).

#### Always on Alert

In imagining doomsday disaster, NEO science relies on more than state-of-the-art astronomical observation, the calculus of probabilities, and other such means and procedures; to flesh out its picture of apocalypse, it looks to the history and technology of atomic weaponry, takes the bomb as a touchstone. Time and again in the scientific literature, as in NEO-concerned public discourse and popular entertainment, major asteroid or comet impacts are likened to nuclear explosions. Despite their contrasting moral and political valences (only the meteor's timeless genesis is independent of human desire, intention, agency, volition, cunning, aggression), the two are routinely cast as kindred phenomena, comparable in their risks, their physics, and their effects. The energies they release, the ejecta they produce, the craters they leave, the blazes they ignite, the skies they blacken, the ravages they inflict, as well as the fears they arouse, the tales and dreams they spawn, the theoretical models they corroborate, the institutional forms and practices they underpin, the operations of power, fantasy, and ideology they alibi and enable—to be sure, in the realms of science, culture, and government, analogies and reciprocities between meteoric Earth-collisions and atomic detonations are rich and plentiful (see Davis).

Chapman and Morrison's influential *Nature* article offers a defining instance. In it, the threat of extraterrestrial "projectiles" is pointedly compared to "other natural and human-generated hazards" ("Impacts on the Earth" 33). Floods, cyclones, tornadoes, firestorms, earthquakes, droughts, tsunamis, and volcanic eruptions, along with "the very worst technological accidents of modern society," such as airliner crashes and the Bhopal disaster, all receive explicit mention. "A globally catastrophic impact, however, exceeds all [these] other disasters in that such an event could kill much of the world's population over the course of a few months or years," the authors declare. "Furthermore, the globally catastrophic impact is qualitatively different from other more familiar hazards in its synergistic effects upon the entire planet" (37). Ultimately, only "nuclear war" and its corollary, nuclear winter, the aftermath to end all aftermaths, are truly akin to "a global impact catastrophe [that] could lead to the breakdown of civilization" (33). Five years earlier, in *Cosmic Catastrophes*, these same NEO scientists defended their decision to include a chapter on nuclear winter—other than "human-wrought climate changes," the only anthropogenic calamity treated at length in the book—by claiming for it a "cosmic significance":

Perhaps it takes a cosmic perspective to appreciate, and deal with, the global consequences of such a man-made Armageddon. But in a larger sense, the evolution of life and development of civilization on our world is itself a cosmic process. When living things evolve to the point where their activities can transform the very climate of their planet, they emerge into cosmic significance.

(v, 122)

The hypothetical asteroid that wiped out the dinosaurs is held to be like the conjectural impactor that would initiate for humankind a ruinous chain reaction. (NEO scientists typically envisage not the extinction of Homo sapiens but the abject collapse of advanced industrial societies-a mythology here, then, of sudden world-historical retrogression, of degeneration and reprimitivization, rather than of species annihilation.)<sup>10</sup> In turn, the damage done by that impactor is supposed to be similar to the destruction caused by an imagined nuclear war. These three mutually informing speculative scientific catastrophe theories do political as well as intellectual work; they are not only symbolically but socially and materially effective. As Doug Davis has shown, Luis and Walter Alvarez's "impact-extinction theory emerged from the Cold War's state of conflict, and in the process turned that conflict's nuclear threat into a state of nature." In addition to abetting the ideological naturalization of the era's geopolitical enmities and precarities, "it rallied the resources of a scientific community that had otherwise been doing the science needed to fight World War III, and ultimately taught statesmen how that war might end in a nuclear winter" (Davis 463). More recently, NEO-scientific logics and conceits have been wedded to the objectives of national security and recruited for the militarization of space. During the 1980s and 1990s, Mellor contends, "the promotion of the asteroid impact threat helped make the idea of war in space more acceptable and helped justify the continued development of space-based weaponry." It ratified a mode of thought and speech

founded on fear of the unknown and the assumption that advanced technology could usher in a safer era. In so doing, it resonated with the politics of fear and the technologies of permanent war that are now at the centre of US defence policy.

(Mellor, "Colliding Worlds" 522)

Consider, in this light, NASA's new Planetary Defense Coordination Office (PDCO). Established in January of 2016, the PDCO now controls and encompasses the NEO Observations Program. As if the office's almost science-fictional appellation did not make matters plain enough, the revamped administrative hierarchy leaves little doubt as to its mission and priorities. Whereas the program seeks to scientifically investigate all close approaches, the PDCO is interested exclusively in the detection and tracking of a narrower class of near-Earth object, namely, those deemed "potentially hazardous." Not incidentally, it also is responsible for developing techniques for deflecting or redirecting any large asteroid or comet discovered to be on a collision course with the Earth. In circumstances in which it has been determined that preventive measures would be impossible or ineffectual, the office collaborates with the State Department and the Federal Emergency Management Agency to formulate a disaster-response plan and to oversee rescue operations. Finally, the PDCO is a communications nerve center, in charge of issuing warnings and distributing "timely and accurate information to the Government, the media, and the public" about potentially hazardous objects (NASA, "Planetary Defense Coordination Office").

In *Space and the American Imagination*, Howard McCurdy points out that fears and trepidations about bolt-from-the-blue catastrophes ran rampant during the Cold War, as

science revealed terrible ways in which the planet might be destroyed. All of the doomsday scenarios, both astronomical and human in origin, fell from the sky. This led naturally to the conclusion that activities taking place above the surface of the Earth

—not on the ground, not over the moon, but, as it were, in the middle—"would determine the future of the world" (81). NASA's project of planetary defense adopts and radically extends key Cold War agendas, rationales, and purposes. It marshals scientific expertise, technical intelligence, militaristic metaphors, futurist projections, and pop-cultural fantasies in the name of national security. Or, more precisely, in the name of a speculative national security that is supposedly

simultaneously a *total terrestrial* security, an *absolute geospheric* security—in a sense, the maximal security imaginable. Conflating a banal national ideological guarantee (territorial security) with an extravagant ecumenical promise (comprehensive Earth protection, "spaceguardianship"), the trope of "planetary defense" works to transfigure the profane dream of hegemonic invulnerability into the hope of universal salvation through benevolent technocracy.

The real imperatives driving the PDCO are, of course, rather more down to earth. Since its inception, the PDCO has formed an essential component of what Joseph Masco calls "an ever-expanding, always-on-alert global security apparatus" engineered by "American power" to "administer the global future" (10). Such an imperialist apparatus, Masco adds, as if describing the impetus behind the Torino Impact Hazard Scale rather than laying the predicate for his analysis of the now-defunct U.S. Homeland Security Advisory System color chart (the two risk infographics are cognates in any case), "requires a new kind of expert psychopolitics that is not grounded in the effort to establish facts but rather is committed to generating speculative futures (imagined dangers of cataclysmic scale) that it will then need to counter" (20).<sup>11</sup>

In February of 2013, the Chelyabinsk fireball and its fallen remains provided spectacular and tangible proof of the eventuality of future asteroidal or cometary cataclysm, as well as fodder for a range of scientific, governmental, and popular inquiries and assessments, depictions and strategic-defensive imaginings. (The NASA Office of Inspector General included a description and photograph of the fireball on the very first page of its 2014 report, "NASA's Efforts to Identify Near-Earth Objects and Mitigate Hazards," in direct response to which the PDCO was founded.) Upon the bodies of the star-crossed few, those 1,600 or so who happened to be within its impact horizon—and who, like everybody else, *did not see it coming*—the superbolide visited one or more kinds of unlucky blow. However, to the eyes and ears of the fascinated many, the millions around the world who first had the fortune to encounter its visual or audiovisual mediation—in print, on television, on the web, on social networks—the meteor's declination and explosion delivered a marvelous mix of mental astonishment and sensual excitation.

Perhaps because it awakened primal anxieties or enchantments, perhaps because it summoned archetypal or supernatural images and associations, but surely because of its extraordinariness and sheer unexpectedness, the meteor's representation was destined to become a digital-media sensation. As befalls and befits a mediate-star-become-media-star, the fireball today continues to light up the online universe, where its forgone fortuitous eventness seems fated to a future of infinite commotion, of endless disseminative play and replay. Meanwhile, astronomers and planetary scientists, having failed to forecast and prepare for the space rock's precipitous arrival—this failure to foresee the advent: the mark of their ancient meteorological inheritance—appropriated, examined, and manipulated web-accessible amateur and public videos in a belated effort to reconstruct the intruder's orbit and trajectory through frame-by-frame analysis and other media-forensic methods, thereby reclaiming the rare cosmic occurrence for positive science.

Both the Chelyabinsk meteor's scientific reclamation and its recirculative media stardom were made possible by its contingent mediatized capture by hundreds of random cameras. Yet, for all their happenstance, those cameras and the recordings they casually generated were as much the products of political and cultural necessity as of astronomical coincidence. In modern risk and surveillance societies, in media cultures "always on alert" for threats and thrills alike, the mass proliferation of devices and apparatuses of 24/7 monitoring—of perpetual witnessing, watching, and warning—is by no means accidental. Given their "chance proximity" (as Serres would say) to the airburst, what were the chances that some number of privately mobile, socially networked, smartphone-wielding citizens would *not* manage to frame and reproduce at least some portion of the meteor's downward motion? What was the probability that some percentage of high-tech traffic and security systems in the area would not automatically (inadvertently) do the same? Were we to game it out, so to speak, would we not be inclined to find that the odds were, from the start, stacked in the cameras' favor? Was there not, therefore, the element of a certain inevitability, a

weird inescapability, in this unanticipated constellation of sudden asteroidal emergence and sleepless technological vigilance? If the contemporary meteoric event is haphazard and complex, if together with its mediatized encounter it constitutes a hazardous complex, it is because the threatprepared horizon of the one is the other's post-hoc determinant and, at the same (untimely) time, its prior accident.

#### Notes

- 1 See Durda; Kring and Boslough; and Scharf. See also Borovička et al., "The Trajectory"; Brown et al.; and Popova et al.
- 2 Tiffany makes an important point about Serres's use of the word *temps*: "The French word *temps* means both 'time' and 'weather,' so that each time Serres speaks of the weather, he invokes the inherent temporality of the meteoric phenomenon" (313).
- 3 For more on *kairos* and *chronos* in relation to weather and meteorology, see Peters. Contrary to Golinski, Peters not only opposes the clock to the calendar but associates the former with *kairos* rather than with *chronos*: "To a large degree, [clocks] deal in time as *kairos* (opportunity) in contrast to *chronos* (duration)" (213).
- 4 On the 2004 update, see Morrison et al.; and Thomson 3.
- 5 Quoted matter from Torino Impact Hazard Scale (Center for Near Earth Object Studies).
- 6 Quoted matter from Torino Impact Hazard Scale (Center for Near Earth Object Studies).
- 7 Quoted matter from Torino Impact Hazard Scale (Center for Near Earth Object Studies).
- 8 On the ideological work of "inoculation," see Barthes.
- 9 On the history of thunderstones, see Burke; and Garber.
- 10 The Spacewatch [Snowmass, Colorado] Workshop did *not* equate the destruction of civilization with the total extinction of the human species. Instead, it envisioned an event that might eradicate one year's agriculture and destabilize social and economic structures to the point that a new Dark Ages of even a Stone Age might result.

#### (Chapman and Morrison, Cosmic Catastrophes 279; italics in the original)

11 In contrast to the Torino Scale, the U.S. Homeland Security Advisory System chart *rises* to the color red ("severe risk") and puts green at the bottom ("low risk").

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