

## Introduction: a personal odyssey with comets

Comets are like cats; they have tails, and they do precisely what they want.

David H. Levy, 1996.<sup>1</sup>

Time has not lessened the age-old allure of the comets. In some ways their mystery has only deepened with the years. At each return a comet brings with it the questions which were asked when it was here before, and as it rounds the Sun and backs away toward the long, slow night of its aphelion, it leaves behind with us those questions, still unanswered.

To hunt a speck of moving haze may seem a strange pursuit, but even though we fail the search is still rewarding, for in no better way can we come face to face, night after night, with such a wealth of riches as old Croesus never dreamed of.

Leslie C. Peltier, 1965.<sup>2</sup>

How many of us have looked up at the sky, and marveled at its supposed permanence? The sky on a clear night is one of the most reliable aspects of our lives; at a certain time on a particular date, we *know* that the stars will form their special patterns. This is almost true: Occasionally a comet will appear, interrupting this cosmic serenity and reminding us that even the heavens offer surprises, even the heavens are not immutable.

This book is designed to give its readers a sense of how people go about discovering and observing comets. The approach it follows combines a history of the field with the latest techniques for finding and observing comets. You can dip into the book at any part or chapter you like, but if you read the chapters as written, you will follow a natural progression of how our understanding of comets has evolved over time.

This is my sixth book about comets, a subject that continues to play a vital role in my own life.<sup>3</sup> That interest can be traced back to an airplane vapor trail

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*Figure I.1.* On March 23/24, 1996, Canadian amateur astronomer Leo Enright took this photograph of Comet Hyakutake (C/1996 B2) at Sharbot Lake, Ontario, using a Canon 135 mm at  $f/2.5$ , with Kodak Ektachrome 1600 Professional film. Gamma Bootis is the brightest star inside the comet's tail. Courtesy Leo Enright.

on a sunny afternoon at the Hebrew school in Montreal. We kids were sitting around and chatting, waiting for our teacher to arrive, when I saw what looked like a comet with a bright trail hanging in the western sky. Since it did not appear to move, I thought it could not be an airplane. Could it be a comet, I recall thinking, and could it even be that I had discovered a comet? For a few minutes I was pretty excited, but then Mr. Mushkin arrived, our class began, and I forgot about the great Levy comet of 1959. I guess it was not a comet, for something bright enough to be seen in daylight would have surely made the annals of observing history. It might have been a plane moving directly toward or away from me. Frankly, to this day I am unsure what it really was.

Several months later, in elementary school, our sixth-grade teacher assigned each of us to give a 3-minute lecture in class. Terrified to talk in front of an audience, and especially in front of our strict teacher Mr. Powter, I spent many hours thinking not about a choice of topic but about how I could try to present a speech without actually having to face my sixth-grade peers. When speech day came, however, I was prepared. I presented a verbal tome on comets, but I used no notes. I had memorized everything I wanted to say, but in order not to have to face the audience, I carried with me a blank sheet of paper. Since my source

was Leon Housman and Jack Coggins's *The Big Book of Stars*, a children's book I still have,<sup>4</sup> I can recall what I said that faroff day. Comets, I intoned, consist of a nucleus, a coma, and a tail – all still correct, although the 100+ mile diameter I quoted for a typical comet nucleus was off by a factor of ten. I mentioned Halley's comet, then on its way for a future rendezvous with Earth – its 1986 visit seemed a very long time in the future back then.

I also remember saying – possibly in reference to my own observation from a year earlier – that it was possible to discover comets, and that some people spend many years searching through small telescopes in the hope that they might, some day, find a new comet. Still holding my blank sheet of paper, I was tremendously relieved when the presentation was over. After the class applauded politely, Mr. Powter said, "Great speech, Levy. Can I see your notes?" The children in the front row, who easily saw my blank paper ploy, broke out in laughter.

That was March, 1960. By the end of that summer I was a stargazer committed to spending the next several years learning as much as I could about all aspects of astronomy. Comets were a part of those frenetic early years in astronomy, but my specific interest in them did not really return until October 1965, when I read about the discovery of a comet by two Japanese amateur astronomers, Kaoru Ikeya and Tsutomu Seki. The comet was a sun-grazer, headed straight toward a rendezvous with the Sun during which it would complete a hairpin turn some 300 000 kilometers from the Sun's photosphere.

The anticipation of seeing this wondrous comet really ignited my passion for comet hunting. That fall, while walking to an early French oral examination in tenth grade, and knowing that one of the questions would pertain to my choice of hobby, I decided to respond "Je veux découvrir une comete." It felt like the right thing to do at the time, and I especially enjoyed planning a search strategy. I knew that the best place for a visual, amateur search would be in the evening, after dark in the west, or in the morning, before dawn in the east; comets tend to be brighter when they are close to the Sun. However, since clouds often block the Montreal sky, my early searching took place whenever I could find a clear night. It was 19 years before I found my first new comet in 1984. Since then I have found, independently or with others, 20 other new comets.

Nothing in all those early years could have prepared me for what happened in the momentous spring of 1993. Observing with Gene and Carolyn Shoemaker, I took two photographs that recorded the motion of Comet Shoemaker–Levy 9 just a few months after an encounter with the tidal force of Jupiter that tore the comet into a string of fragments. This completely

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disrupted object looked like a squashed comet, as Carolyn described it, but through larger telescopes it resembled a string of pearls as its 21 pieces moved through the sky. On May 22, 1993, the International Astronomical Union announced that the comet, named Shoemaker–Levy 9, would collide with Jupiter in July 1994. Humanity learned from the catastrophic impact that followed, for as Comet Shoemaker–Levy 9 struck Jupiter, it provided an important lesson in our heritage: The impact recalled a solar system that had a violent youth, with comets plummeting into planets, bringing with them the elements of organic materials – carbon, hydrogen, oxygen, and nitrogen. On at least one of those planets, life arose from those chemicals.

A childhood whim and a grade-school assignment later developed into my lifelong passion for comets. In this book, I share the observing techniques that have been developed over the years by people who have enjoyed watching comets as much as I have. These techniques span the gamut from visual observations and searching, to photography, to electronic charge-coupled devices (CCDs). For visual observing, I decided years ago that if I planned to discover a comet, I should know what comets look like by observing as many known comets as possible. In 1985, I leaped from visual to CCD observing by joining the Near-Nucleus Studies Net of the International Halley Watch. As part of that effort, Steve Larson and I used a CCD to build a nightly record of the apparition of Halley's comet from late 1985 until 1989, and in the course of that survey recorded many other comets as well.

My work with conventional photography of comets began in 1970, when I photographed Comet Bennett. In 1988 I added photography to my search and observation program, and a few months later joined Gene and Carolyn Shoemaker's photographic search program. Over their careers together, the Shoemakers exposed more than 26000 films. Being a part of that effort gave me a sense of what photography can accomplish while observing comets and searching for them. Now my wife Wendee and I, along with Carolyn Shoemaker, are part of a group called the Jarnac Comet Survey. We are searching in all three ways – visually, photographically, and with CCDs, and we try to record the known comets as they make their way through the sky. Just as I did in sixth grade, I still think that writing about a subject is a great way to learn about it. Through writing this book I hope that our group will be able to refine and improve its observations. At the same time, I hope that you, as a reader, will get an idea of what comet observation is all about. Whether you are just casually interested in comets and how you observe them, or if you want to begin or expand an observing program of your own, I hope that this book will give you a sense of the passion that we comet observers have.

## NOTES

1. *The Today Show*, NBC Television, March 23, 1996.
2. Leslie C. Peltier, *Starlight Nights: The Adventures of a Star-Gazer* (New York: Harper & Row, 1965), 231.
3. The first five books are:

*Observe: Comets*, with S. J. Edberg. (Astronomical League, 1985).

*An Observing Guide for Comets, Asteroids, Meteors, and Zodiacal Light*, with Steve Edberg.

Revised and expanded edition of *Observe: Comets* (Cambridge: Cambridge University Press, 1994).

*The Quest for Comets: An Explosive Trail of Beauty and Danger* (New York: Plenum, 1994).

Paperback editions from New York: Avon Books, 1995, and Oxford: Oxford University Press, 1995).

*Impact Jupiter: The Crash of Comet Shoemaker–Levy 9* (New York: Plenum, 1995).

*Comets: Creators and Destroyers* (New York: Simon & Schuster, 1998).

There is also a slide set:

*Comet Shoemaker–Levy 9 Slide Set*, with the editors of *Sky & Telescope* (Cambridge, MA: Sky Publishing, 1994).

4. Leon A. Housman and Jack Coggins, *The Big Book of Stars* (New York: Grosset & Dunlap, 1955).

PART I

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## Why observe comets?

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# 1

## Of history, superstition, magic, and science

When beggars die there are no comets seen;  
The heavens themselves blaze forth the death of princes.

Shakespeare, *Julius Caesar*<sup>1</sup>

When Shakespeare wrote that comets import change of times and states, he had something else in mind other than a comet literally plowing into Earth, with devastation so great as to destroy most of life here. No larger than a village, a comet moves lazily around the Sun, brightening and becoming more active as it closes in from a place beyond Jupiter, past the orbits of Mars, close to the orbit of Earth. Those of us who saw two spectacular comets in 1996 and 1997 will not soon forget those almost fearsome sights in the heavens. In March, 1996, the first of those two comets, Hyakutake, sported a filmy tail that stretched across the entire sky. The sight was remarkable, even in our time when we supposedly understand what a comet is and how it orbits the Sun. Past cultures, dating back to biblical times, were terrified by appearances so unusual that those who viewed them kept detailed records of their paths across the sky. “A comet appeared in the heavens like a twisting serpent,” wrote Nicetus in 1182, “now writhing and coiling back upon itself; now it would terrify people with its gaping mouth; as if lusting for human blood, it seemed about to slake its thirst.”<sup>2</sup> As late as 1528, Ambroise Pare wrote of a comet:

So horrible was it, so terrible, so great a fright did it engender in the populace, that some died of fear; others fell sick ... this comet was the color of blood; at its extremity we saw the shape of an arm holding a great sword as if about to strike us down. At the end of the blade there were three stars. On either side of the rays of this comet were seen great numbers of axes, knives, bloody swords, amongst which were a great number of hideous human faces, with beards and hair all awry ...<sup>2</sup>

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Now we keep records for different reasons. We want to learn about comets, and their orbits, and most especially we want to track those comets that could someday pose a threat to our planet.

### **A comet in the Bible?**

Humanity's relation with comets dates back as far as historical records take us. This biblical passage from 1 Chronicles appears every year in the Passover Seder: "And David lifted up his eyes, and saw the angel of the Lord stand between the earth and the heaven, having a drawn sword in his hand stretched out over Jerusalem."<sup>3</sup> It describes some "sign" that protested an ill-advised census King David had ordered for his city of Jerusalem. Could that sign have been a comet? The ancient Hebrews, like their Arabic neighbors, enjoyed looking at the night sky and sought meaning among its many stars and events. A bright comet, appearing once every two decades or so, would have attracted their attention as much then as now.

Could King David have witnessed the comet that was apparently observed in Leo in 1002 BC? Or might it have been the comet that appeared half a century later, in the northern sky, around 959 BC. For no special reason other than the timing being about right, I like to think that the 959 BC comet was the comet of David.

### **Broom stars and bushy stars**

It is a good thing that people throughout history have been moved by the passages of comets. Had they been less interested, we would not have such detailed records of their paths across the sky, as well as what they looked like and how their appearance changed with time. We have records of comets dating back to 1059 BC, when a comet with a tail pointing to the east appeared in the evening sky. Chinese recorders eventually noted two types of comet, the *po* and the *hui*. The *po*, or bushy star comet, had large fuzzy "coma" or atmosphere. If such comets had tails, they were unremarkable. The *hui* or broom star comet, on the other hand, was noted especially for its tail. Centuries later, observing from a different time and place, the Greek philosopher Aristotle divided comets into two classification groups: tailed and tailless. The tailless variety he called fringed and bearded stars. However, Aristotle did more than offer descriptions: He attempted to define the *nature* of comets. He thought that they formed when the Earth exhales hot, dry air into the upper reaches of its atmosphere. This view lasted for so long that it became almost impossible to challenge.



### The heavens blaze forth the death of princes

Our understanding of comets as portents lasted a very long time. The ancient Romans feared them, and at least some in the audiences who came to watch Shakespeare's *Julius Caesar* 1500 years later still feared them. Shakespeare invoked comets and their supposed effects frequently in his plays. In *Julius Caesar*, Calpurnia begs her husband to stay away from the Senate. When Caesar asks why, she explains:

Caesar, I never stood on ceremonies,  
 Yet now they fright me. There is one within,  
 Besides the things we have heard and seen,  
 Recounts most horrid sights seen by the watch.  
 A lioness hath whelped in the streets;  
 And graves have yawn'd and yielded up their dead;  
 Fierce fiery warriors fight upon the clouds,...  
 And ghosts did shriek and squeal about the streets.  
 O Caesar, these things are beyond all use,  
 And I do fear them!<sup>4</sup>

When all these events still did not move Caesar, Calpurnia added the appearance of comets in the night:

When beggars die there are no comets seen;  
 The heavens themselves blaze forth the death of princes.<sup>1</sup>

Did Calpurnia actually see a comet? Possibly she did in real life, but not before Caesar was murdered on the Ides of March, 44 BC at the foot of Pompey's statue. Two months later, during a series of games, a bright comet with a tail perhaps 12 degrees long – half the length of the Big Dipper (or Plough) – moved out of the northern sky. Plutarch wrote “among the divine portents there was also the great comet; it appeared very bright for seven nights after the murder of Caesar, then disappeared.”<sup>5</sup> Calpurnius Siculus went further, blaming the comet for the civil war that followed: “when, on the murder of Caesar, a comet pronounced fatal war for the wretched people.”<sup>5</sup>

To the people of Caesar's time, as to some in Shakespeare's time, comets were portents. Yet from this fear and attention came the beginnings of wisdom in the mind of a member of Emperor Nero's government. He was the writer Lucius Annaeus Seneca, and he lived in Rome in the first century AD. His writings, particularly his *Quaestiones Naturales*, made him immortal, but his life was ended at the whim of Emperor Nero. One chapter of the *Quaestiones*, called *De Cometis*, is a priceless look into the past of what people thought about comets.

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*Figure 1.1.* A view of Comet Hyakutake (C/1996 B2) showing the comet behind a silhouette of a saguaro cactus plant, taken by the author on March 26, 1996, in Arizona, using a Yashika twin-lens camera.

Born around 4 BC, Seneca lived through the reigns of Caligula, Claudius, and Nero. When 17-year-old Nero became Emperor of Rome, Seneca, as his tutor, enjoyed considerable power in the government. In AD 59, Nero murdered his mother, and then sought Seneca's forgiveness. As Nero's tyranny set in, Seneca struggled to retain the Emperor's favor by using celestial events, like comets, to excuse his leader: A year after the murder, he invoked the comet of AD 60: "There is no reason to suppose," he wrote, "that the recent [comet] which appeared during the reign of Nero Caesar – which has redeemed comets