

ASTRONOMY TAKES THE STAND: USING THE IEAVENS TO LVE CRIMES

Crime scenes reflect the actions of individuals, but illuminating those actions is often difficult. Astronomy offers knowledge and skills to bring the truth to light in these situations.

by Mary Ellen Pistalu



Forensic astronomy is a field in forensics that involves the use of astronomy in criminal and civil legal actions. This field has been around for quite some time, albeit somewhat quiet. Consider for examples that

Abe Lincoln was successful in defending a legal case by describing the location of the Moon on the night of the offense;

* contemporary researchers explained a crucial moment in the Civil War by determining that General Stonewall Jackson was shot by his own troops when his image was silhouetted on a full Moon, making him unrecognizable; and

investigators were recently able to pinpoint the moment that Ansel Adams took a prized photo of the Moon rising over Half Dome in Yosemite Valley, 4:14 p.m. on 28 December 1960.

A forensic astronomer is someone who draws on her or his education in the fields of

astronomy and law cumulatively or independently—a person for whom navigating legal seas is as familiar as knowing the day and night sky at different times of the year. This knowledge can be used to corroborate or deny testimony made by alleged offenders or alleged victims of crime.

Sky Surveillance

Astronomers have studied the real or apparent motions of Earth, the Moon, the Sun, and other members of the Solar System for centuries. When astronomical data are used in litigation, the motions of these heavenly bodies can become critical tools. This includes queries into the time of an alleged crime and the availability of visual aid from the Moon or Sun: a forensic astronomer can study a photograph taken in daylight and ascertain the date and time the photograph was taken by way of measuring shadows and/or the positions of celestial objects. This is imperative in cases where an alleged offender claims to be in a photograph supposedly taken at the same time the alleged crime was committed.

Moreover, forensic astronomy can be used to determine if the brilliance of the Sun was the cause of automobile accidents, and the brightness of moonshine can be calculated to determine the amount of light on a particular night and in a specific area. This information can, in turn, be used to disprove the testimony of a witness by showing that they could not have possibly seen what they testified to seeing or have been where they stated they were; the information can also substantiate that same testimony. For example, an alleged offender may assert that "on the night of the crime there was a full Moon." A forensic astronomer can testify as an expert witness in a court of law that, say, the Moon was in a different phase and could not have been visible to the offender. This, in turn, brings the alleged offender's creditability to be in question.

According to Patrick McCarthy, forensic astronomer and President of Astronomical Facts (*www.astronomicalfacts.com*), legal research teams are often requested to find "Furnishing the actual time of sunset on the date in question can change vague and individual observations into reliable statements."

expert declarations of sunrise or sunset for use in legal proceedings. Indeed, astronomical data can establish an objective foundation upon which to argue certain issues, and determining the time of an event using those data can be vital to the prosecution and/or the defense and may set the outcome of a case.

McCarthy contends in a 2003 article in *LegalTimes.com* entitled "Astronomical Importance," that, for the most part, people use their perception of time to express when something happened: "just before nightfall," "right after sundown," "before dusk," and "it was still light out," are common examples. Furnishing the actual time of sunset on the date in question can change vague and individual observations into reliable statements. "Just after Sunset" could actually translate into "about 6:07 p.m.," "just before dark" might become "approximately 6:35 p.m."

The [astro-]Legal Vernacular

While all states' laws, policies, and regulations make use of seemingly astro-type language, let us consider several examples, which includes words and phrases such as "nighttime" and "onset of darkness," from the laws and regulations of California's 2003 penal and vehicular codes. The 2003 California Vehicle Code 24602 states:

"(a) Any vehicle may be equipped with not more than two red fog tail lamps mounted on the rear which may be lighted, in addition to the required tail lamps, only when atmospheric conditions, such as fog, rain, snow, smoke, or dust, reduce the **daytime** or **nighttime** visibility of other vehicles to less than 500 feet (Pg 1216)."

The 2003 California Penal Code 840 states:

"An arrest for the commission of a felony may be made on any day and at any time of the **day** or **night**. An arrest for the commission of a misdemeanor or an infraction cannot be made between the hours of 10 o'clock p.m. of any day and 6 o'clock a.m. of the succeeding day, unless: (1) The arrest is made without a warrant pursuant to Section 836 or 837. (2) The arrest is made in a public place. (3) The arrest is made when the person is in custody pursuant to another lawful arrest. (4) The arrest is made pursuant to a war(Above) Although everyone has her or his own idea about what constitutes "sunset" (and sunrise, too), the United States Naval Observatory defines "sunset" (and sunrise, too) as the time when the Sun's upper edge is on the horizon.



Not a scientist yet possessing a keen analytical ability, Abraham Lincoln once served as defending attorney for a case in which he used knowledge of the Moon's position on the night of the crime. Image courtesy of the History Cooperative.



rant, which, for good cause shown, directs that it may be served at any time of the **day** or **night** (Pg. 393)."

The 2003 California Penal Code 464 states:

"Any person who, with intent to commit crime, enters, either by day or by night, any building, whether inhabited or not, and opens or attempts to open any vault, safe, or other secure place by use of acetylene torch or electric arc, burning bar, thermal lance, oxygen lance, or any other similar device capable of burning through steel, concrete, or any other solid substance, or by use of nitroglycerine, dynamite, gunpowder, or any other explosive, is guilty of a felony and, upon conviction, shall be punished by imprisonment in the state prison for a term of three, five, or seven years (Pg. 204)."

"Nighttime" is generally thought of by the general public as beginning about one-half hour after sunset and ending about one-half hour before sunrise. However, legally, according to New York Penal Law § 140.20 (2003), it is defined as whenever it is too dark to distinguish a person's face or to identify them. This element is deliberate to affect the behavior of covertness common to burglaries. According to the Burlington, Massachusetts, Academy Online (*www.bpd.org/burg.htm*), "no more than roughly one half of all burglaries are committed at night; nevertheless, all states currently recognize nighttime intrusions as an aggravating circumstance. Still, some states have eliminated the nighttime element completely."

The words "dusk," "twilight," and "nightfall" are frequently heard in the courtroom, according to Larry Ciupik, forensic astronomer and a thirty-one-year veteran astronomer of the Adler Planetarium in Chicago. But these are not exact concepts. On the one hand, "dusk," according to the American Heritage Dictionary, is the period "tending towards darkness." "Nightfall" has a similar ambiguity. The term "twilight," on the other hand, has a specific scientific definition: it is, again according to the American Heritage Dictionary, "the diffused light from the sky during the early evening or early morning when the Sun is below the horizon and its light is refracted by the Earth's atmosphere." When this is correctly explained to a jury it changes a vague statement, which is subjec-



The United States Naval Observatory is charged as the United States's authority for all astronomical data, but you will never see an astronomer from the Naval Observatory serve as an expert witness in a trial—unless the federal government is a party to the action. The USNO website, which includes a wealth of time and time-keeping information, is located at www.usno.navy.mil.

tive and open to individual understanding, into definitive terms with an objective base.

Defining the Time

Ciupik contends that forensic astronomy offers a captivating look at some realistic uses

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Definitions by the United States Naval Observatory

A s the nation's astronomical authority, the USNO is responsible for specific definitions. Examples of those important for and often used in forensic astronomy include triply defined twilight, sun(rise/set), and moon(rise/set). Consider the three types of twilight:

Civil Twilight — Begins in the morning and ends in the evening when the center of the Sun is geometrically six degrees below the horizon. This is the limit at which twilight lighting is adequate (when weather conditions are good). In the morning before the commencement of civil twilight and in the evening after the end of civil twilight, artificial lighting is more often than not required to carry on outdoor activities. Complete darkness, however, ends sometime prior to the beginning

of morning civil twilight and begins sometime after the end of evening civil twilight.

Nautical Twilight — Commences in the morning and ends in the evening, when the center of the Sun is geometrically twelve degrees below the horizon. At the commencement or conclusion of nautical twilight, under good atmospheric conditions and without any other lighting, general outlines of ground objects may be discernible, but detailed views of objects are not possible.

Astronomical Twilight — Starts in the morning and ends in the evening when the center of the Sun is geometrically eighteen degrees below the horizon. Prior to the beginning of astronomical twilight in the morning and after the end of astronomical twilight in the evening the Sun does not contribute to sky illumination.

As described by the USNO, "sunrise" and "sunset" typically refer to the times when the upper edge of the disk of the Sun is on the horizon: considered unobstructed relative to the location of interest, atmospheric conditions assumed to be average, and location in a level region on Earth's surface. The USNO states that "moonrise" and "moonset" times are computed for precisely the same conditions as for sunrise and sunset. However, moonrise and moonset can come about at any time during a 24-hour period and, as a result, it is frequently likely for either the Moon to be seen during daylight or to be absent at night. It is also possible that a moonrise or moonset does not occur relative to a specific place on a given date.

-M. E. P.

of a seemingly obscure focus. Just like DNA investigation and computer fingerprinting, a well developed comprehension of the sky can offer equally accurate and specific evidence for legal proceedings. This is significant, according to Ciupik, in cases with issues of lighting conditions. Some of the questions that need to be answered in these cases are:

Was there sufficient light to see an incident clearly and identify the individuals involved?

Was there enough light to see colors clearly?

Was there too much light?

When the Sun is low on the horizon, it can blind a witness or a driver. Likewise, the amount of moonlight on a particular night can become an important factor in some less-lighted suburbs and most rural areas when the question of visibility arises.

It is interesting, too, that the time an event occurred can be the determining factor in the

type of offense charged. Harald Schweizer, a criminologist at California State University, Fresno, points out that many statutes on burglary differentiate between day and night. Unlawful entrance during daylight is a misdemeanor; at night it is a felony offense. Lawmakers defined the generic phrase "hours of darkness" as starting thirty minutes after sunset and continuing until thirty minutes before sunrise. Once the precise time of sunset or sunrise is established for the place and day in question, Schweizer states, law enforcement will appropriately charge offenders under this statute.

According to McCarthy, use of data from a location different from the scene of the crime is likely to result in improper charges being filed. This is because the Sun's shadow travels about 16.25 miles every minute. Further, most jurisdictions do not accept the times of sunrise and sunset that is published in the newspapers.

By an act of Congress, the U. S. Naval Observatory (USNO) is the authority for all astronomical data in the United States. Nonetheless, federal regulations prohibit the

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The American Academy of Forensic Sciences is a professional society dedicated to the achievement of justice "through the application of sciences to the processes of law." The address of the Academy's website is www.aafs.org.

USNO from providing expert witnesses for use in litigation, unless the federal government is a party to the action.

McCarthy explains that because astronomical events occur simultaneously over a large portion of Earth, astronomers created a system to calculate the time of an event in question for any location worldwide.

The Astronomical Almanac, published yearly by the USNO and in cooperation with Her Majesty's Nautical Almanac Office, is recognized worldwide as a standard reference source for astronomy and navigation data. The USNO also publishes annually the Nautical Almanac, the Air Almanac, Astronomical Phenomena, and the Astronomical Almanac Online (asa.usno.navy.mil). As one may learn through these volumes or the USNO's website, information for any location on Earth's surface, for any date (past or future), can be determined with sufficient accuracy for civil matters through a series of standard calculations. A lawyer can guickly and with minimal examination of the issues determine just what data are required to sustain or refute a point of dispute in a case.

Astro Forensics in Action

Many people mistakenly believe that knowledge of the time of sunset will establish just how dark it was at a particular time. More appropriately, one should ascertain the time of twilight, which is described by McCarthy as the period when light is refracted from the Sun, which is beneath the horizon, through the atmosphere to Earth's surface. The light level during the various periods of twilight range from levels undetectable by the human eye to levels where the natural light is sufficient to conduct normal outdoor activities without additional (artificial) "Sampson was asked to determine the location and brightness of the Moon to reconstruct the light environment during a night accident."

lighting. The later period, known as "civil twilight," is when the Sun is less than six degrees below the horizon. A rule-of-thumb definition of twilight provided by McCarthy is "the period when a person can read a newspaper outside, without lights, while the Sun is below the horizon." There are also periods called "nautical twilight" and "astronomical twilight." Additionally, twilight as defined by the USNO is "before sunrise and again after sunset when there are intervals of time during which there is natural light provided by the upper atmosphere, which does receive direct sunlight and reflects part of it toward the Earth's surface." The major determinants of the amount of natural light during twilight are the state of the atmosphere—local weather conditions, in particular—as best determined at the actual time and place of events. Knowledge of the Moon's phases, timings, and location can aid one in determining the time of an event.

The forensic work of Russell Sampson, astronomer at Eastern Connecticut State University, includes the use of astronomical findings in the aid of criminal and civil litigation. In particular, his main area of research is "atmospheric refraction of high-zenith-angle astronomical objects"—refraction of the light of the setting Sun as it passes through Earth's atmosphere. This work requires that he maintain an understanding of positional astronomy as well as meteorology. These tools are what have given him the skills necessary to satisfy common forensic astronomy requests. In order to see the practical use of this specialty, here are a few examples.

Sampson states that he has been asked to provide expert testimony in many cases involving traffic accidents. In the majority of the cases the persons concerned were interested in ascertaining if the Sun could have been a factor in their accidents; perhaps, to illustrate, drivers may have had their vision impaired by the glare of the Sun. Sampson's job as a forensic astronomer is to determine the exact location of the Sun at the time of an accident.

In a variant of this, Sampson was once asked to determine the location and brightness of the Moon in order to reconstruct the light environment during a night accident that happened along an unlit highway. Sampson states, however, that one of his most interesting cases (another one Moonrelated) required that he determine the phase and visibility of the Moon on a particular night and time. This made it possible to support or refute a key witness's recollection of the date and time of an alleged crime. One of the case's crucial witnesses remembered the Moon to be full on the night in question. Sampson showed that the Moon was, in fact, close to new phase on that night and could not have been visible, bringing into question the witness's credibility.

During the 56th Annual Meeting of the American Academy of Forensic Sciences in February 2004, an exciting paper related to forensic astronomy and entitled "Applications of Forensic Astronomy in Turkey" was presented by H. Bülent Üner, Emre Albek, and Ismail Cakir. In their paper, the three Turkish scientists provide details of another application of forensic astronomy: in Turkey, with its mostly Islamic population, people involved in a criminal case sometimes report the time of occurrence in association with the Muezzin's call for prayer. In such cases forensic astronomers have to calculate the exact hour of the praying call in relation to the time of the alleged crime.

"A lawyer can quickly determine just what data are required to sustain or refute a point of dispute in a case."

Norman Sperling, editor of the Journal of Irreproducible Results, described to me several cases in which he was either directly involved or had studied the case details. As he discussed with me the Billionaire Boy's Club, Sperling stated that the book by Sue Horton uncritically swallows the testimony of the accuser, Dean Karny. Sperling testified at BBC-leader Joe Hunt's re-trial, proving that Karny was lying about how dark the sky was on the night of the murder: Karny said it was so dark in the desert that "you couldn't see your hand in front of your face." According to Sperling, all astronomers know that starlight is significant if it helps one recognize people and even wires on the ground.

According to Sperling, Karny was lying, and Horton and the prosecution were mistaken to base their prosecution on his statements. Sperling further states: "The fact that Karny was lying does not mean that Hunt is telling the whole truth!" Hunt was acquitted, the prosecution dropped any further appeals, and all other indictments based on Karny's accusations were dropped.

Contrary to the prevalent view (no doubt fostered and developed by Hollywood), most disputes do not end in a courtroom trial. They are often settled outside the courtroom based on the testimony of experts who can make critical contributions at any phase of the litigation process. Virtually every day one can hear of a serious accident that is being examined and reconstructed by experts who are members of a specialized group retained by either the prosecution or the defense to conduct a particular investigation.

The legal profession and the courts are becoming increasingly more accepting of accident reconstruction and its importance in ascertaining responsibility—hence, the growing influence of forensic astronomers on legal cases. Lawyers are also starting to recognize that accident-reconstruction investigators are specialists with special, "scientific" expertise. As a result of this recognition, the profession of forensic astronomy can only grow. Having knowledge of the workings of the Universe—and bringing it into the courtroom—can only make the legal system more fair and change a case from obscure to obvious.

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