A Collision in the Solar System
Observations of the First Impact of the Comet Shoemaker-Levy 9 With the Planet Jupiter

By: Jeffrey D. Beish and Carlos E. Hernandez

The First Sighting!

Astronomers all over the world trained their optical and radio telescopes toward the giant planet Jupiter to record the first predicted collision between two Solar System objects. Public reaction was great. The press worked feverishly to report what may become the most extraordinary event in the history of mankind -- when comet Shoemaker-Levy 9 (SL-9) hit the planet Jupiter. Fragment 'A' of this comet was due to hit the backside of Jupiter at 1950 hours Universal Time (U.T.) on July 16th., 1994.

No one could predict the outcome of the encounter between the comet and the gaseous planet. Since the time of Galileo when he made first use of a telescope to observe the heavens there have been no reports of celestial bodies colliding with each other. Now, for the first time astronomers had a front row seat to this event using their latest technology and modern instrumentation, such as the recently repaired Hubble Space Telescope (HST) and many of the world's largest and up-to-date telescopes.

Not to be out done by the major observatories and modern technology, a small group of amateur astronomers in balmy South Florida were first to report the first of twenty predicated impacts of SL-9 on Jupiter. They are members of the Association of Lunar and Planetary Observers (A.L.P.O.).

After having observed Jupiter for several hours during the afternoon of July 16th., 1994 with his backyard 41cm f/6.9 Newtonian telescope, Jeff Beish suddenly yelled out to his fellow observers, "jumping Jupiter, I see it, I see it! The impact has left a great hole in the clouds of Jupiter!" Hearing this, Beish's daughter, Natalie Kay, ran out of the house and onto the observing platform to see what her father was so excited about. While at the eyepiece she remarked that something resembling a "dark smudge is in the bright region on Jupiter just above one of the southern belts." She was referring to the dark spot left by the impact of fragment 'A' of the comet SL-9 in the southern hemisphere bright zone just above the South South Temperate Belt (SSTB). Note, the south is at the top in an inverting telescope.

After observing Jupiter for a couple minutes, Natalie then ran to the house to call their observing partner, Carlos E. Hernandez, to come out and verify their findings. Carlos was very excited to see the effects of the impact and nearly fell off the observing platform. Hearing the commotion Beish's wife, June, came out to see what the yelling was all about. She too climbed the platform and observed the impact site on Jupiter.

Time seemed to stand still those first moments during the discovery. Beish immediately called fellow A.L.P.O. members Donald C. Parker, M.D., in Coral Gables, Florida and Jupiter Recorder, Phillip Budine in Walton, New York to report an unusual feature on Jupiter. Parker, at that moment, was attempting to locate Jupiter in the bright sky with his 41cm f/6 Newtonian reflector. Parker is equipped with a modern CCD camera and was preparing to image the event.

Budine was preparing to find the giant planet and begin observing. A subsequent call from Budine confirmed the impact discovery.

At 2345 U.T. June Beish placed a call to Brian Marsden of the I.A.U. Central Bureau for Astronomical Telegrams (CBAT) in Cambridge, Massachusetts to report the observations. A subsequent call was made to Marsden a short while later and Beish was told he was the first person to identify the comet impact effects. Beish did not report anything until a positive identification of unusual phenomena was made. Although he saw the impact effects or spot where fragment 'A" of the comet had hit Jupiter at 2030 U.T., he thought it was nothing unusual. Beish attributed the dark smudge in the South Tropical Zone on the morning limb of Jupiter as a contrast effect often seen by astronomers while observing a planet in the daytime.

At 0006 U.T., July 17, 1994, Don Parker captured the first CCD images of fragment 'A" of the impact and reported back to the other groups of observers.

DETAILED ACCOUNT OF THE FIRST OBSERVATIONS

The very first observational record of SL-9 fragment 'A (21)' impact site as drawn by Jeff Beish is a sectional sketch of Jupiter's southern hemisphere made on July 16, 1994 at 2130 UT (CMI = 058°, CMII = 132°). The zone (43°S, 101°W) appears as a dark, crescent-shaped albedo feature at the southern border of the South-South Temperate Belt (SSTB) within the South-South Temperate Zone (SSTZ) of Jupiter.

During the first observation the "astronomical seeing" was 5 or 6 (A.L.P.O. scale 0-10[perfect]) and transparency to 5 (A.L.P.O. scale 0-6 [6th magnitude]). At 2130 UT a dull blurry dark area was seen about 10 or 20 degrees away from Jupiter's morning limb in the general latitude of the South Tropical Zone (STZ). The area was barely visible and was only slightly darker than the zone or combination of zone and belt. It appeared to be a "limb effect" or a darkening of the morning limb in that general region. A brief note and rough drawing was made (See Figure 1).

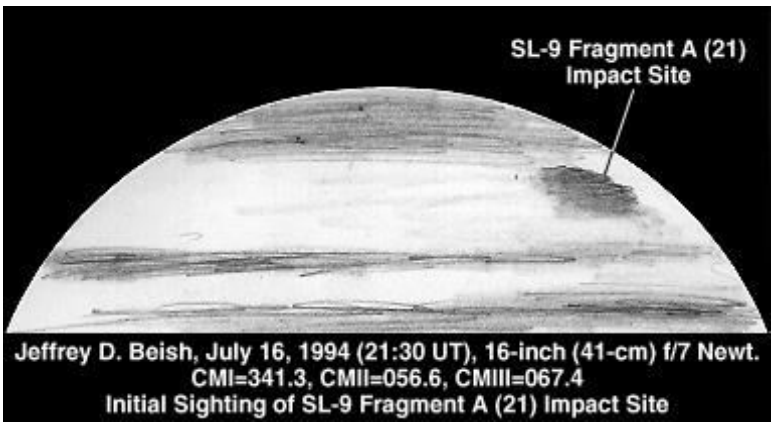

Figure 1. Southern half of Jupiter as drawn by Jeff Beish on 16 July 1994 at 2130 UT using 16-inch f/6.9 Newtonian telescope. Chart shows dark, diffuse feature in South Tropical Zone of Jupiter that turned out to be the first visual observation of the impact site of comet Shoemaker-Levy 9 (1993e) on Jupiter. "Astronomical seeing" poor due to daylight observation and light cirrus clouds.

Notified months in advance of the possibility that comet SL-9 was predicted to hit Jupiter, A.L.P.O.'s Donald C. Parker, an internationally known astrophotographer, began a series of CCD images. This was done to record the appearance of Jupiter a few days before the impending collision.

Alerted to the possible impact of the comet on Jupiter's southern belt or zone system Beish began his observing program months ahead of the predicted encounter. An important aspect in observing Jupiter is to keep a daily record of its appearance. Jupiter's bright clouds and belts change rapidly and can confuse even the most experienced observers at times, especially after a long period between apparitions.

In the CCD image below, Jupiter is shown at central meridian 39° n System I and 136° in System II. Long-enduring ovals DC and DE are shown in the South Temperate Belt (STB) along with a bright round spot just 10° left of the CM. A dark band connecting it to the STB across to the CM is also visible.

A dark ray system was seen on Jupiter preceding the first impact site that appeared to be displaced towards the north (also noted on HST images at the same time) as well as a pair of small, bright ovals following the impact site along it's northern border. The SSTB immediately north of the impact site appears to be displaced to the north, whereas the South South South Temperate Belt (SSSTB) immediately to the south appears to be displaced towards the south. The long-enduring ovals BC and DC are also notes following the central meridian (CM) within the South Temperate Belt (STB).

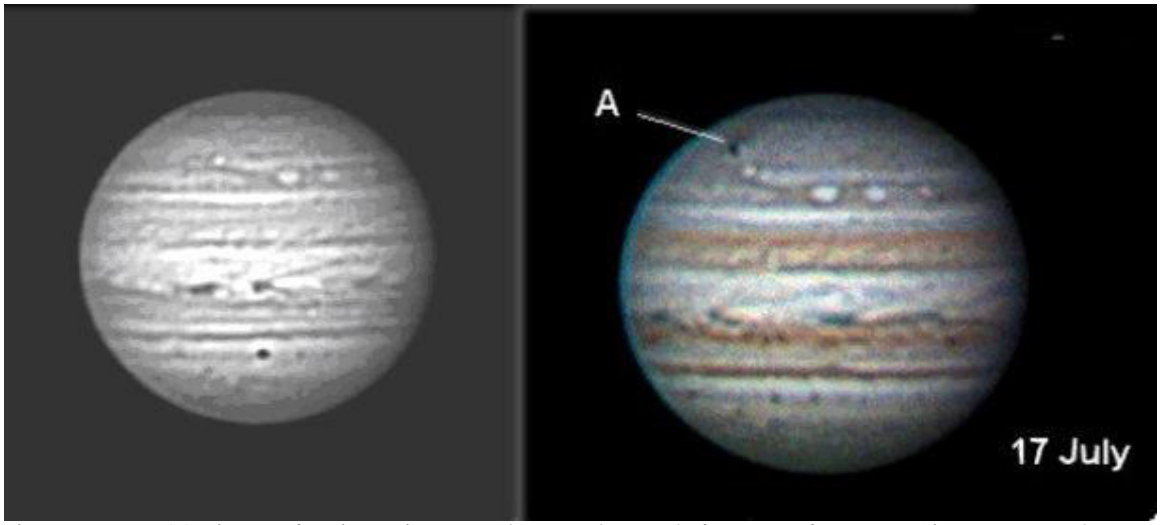

Figure 2 LEFT: CCD image of Jupiter as it appeared on 14 July 1994 before comet fragment 'A' impact occurred. RIGHT: Image of Mars on during July 17, 1994 at 0006 U.T. (CMI = 77°, CMII = 151) after the fragment 'A' impact occurred.. Images by Don Parker, 41cm f/6 reflector in Coral Gables, Florida.

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The SL-9 fragment A (21) impact site is indicated on each drawing in Figure 2 and is noted towards the southern preceding limb as a dark, fan-tailed (or crescent) shaped albedo feature originating at the southern border of the SSTB towards the South Polar Region (SPR) -- (the fan-

shaped feature may be due to ejecta produced by the impact of the comet fragment). A "bridge" of dark material appears to connect to the STB to the SSTB preceding the CM.

The long-enduring ovals (DC and DE) are also visible and indicated on the drawings and the CCD image in figure 2. The SEB is visibly split into two parts or bands, the components being the SEBn and SEBs, separated by a bright, thin zone. A dusky band appears to bisect the Equatorial Zone(EST). Several "Blue Olivarez" festoons
are noted along the southern border of the North Equatorial Belt (NEB) that also appears rather prominent.

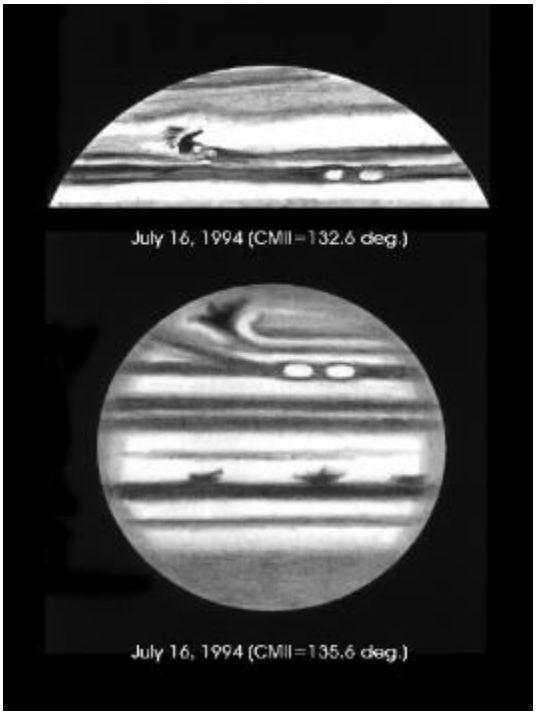

Figure 3 Drawing at the top by Jeff D. Beish is a sectional sketch of Jupiter's southern hemisphere made on July 16, 1994 at 2335 U.T. using a 16-inch (41cm) f/6.9 reflector at 225x 382 x (CMI = 58°, CMII = 132.6°). The bottom drawing was made by Carlos E. Hernandez shortly after Beish at 2340 U.T. on the same date with the same instrument.

THE EVOLUTION OF COMET SL-9 FRAGMENT A (21)

While using a 16-inch (41 cm) f/6.9 Newtonian reflecting telescope Jeff Beish and Carlos Hernandez made observations Jupiter each day from July 16, 1994 throughout July 31, 1994 to plot and record the evolution of SL-9 fragment A (21).

The top drawing in figure 4 by Beish is a sectional sketch of Jupiter's southern hemisphere made on July 16, 1994 at 2335 U.T. (CMI = 058°, CMII = 132°). The SL-9 fragment A (21) impact site and zone (43°S, 101°W) appears as a dark, crescent-shaped albedo feature at the southern border of the South South Temperate Belt (SSTB) within the South South Temperate Zone (SSTZ) of Jupiter.

The center sketch shows fragment A three days later after impact on July 19,1994 (0125 U.T.) as drawn by Hernandez. Impact A is the second dark spot from the preceding limb (left) and has

now lightened significantly since it's initial impact on July 16th. A prominent ray system is visible towards the south (up) from the impact site. Other SL-9 impact sites visible are E (17) on the preceding limb, C (19) just following the CM, and possibly K (12) on the following limb (right).

The bottom sketch in Figure 4 is by Hernandez on July 31, at 0200 U.T. (CMI =134°, CMII = 101°) shows the appearance of the approximate impact longitude of SL-9 fragment A (115° W) which has now disappeared with only a dark streak and a pair of bright ovals to mark it's location. Fragment E is visible as a dark nucleus with several dark projections extending from it just past the CM. Fragment H (14) may possibly be the dark impact site on the preceding limb. The long-enduring oval BC is visible towards the following limb within the STB.

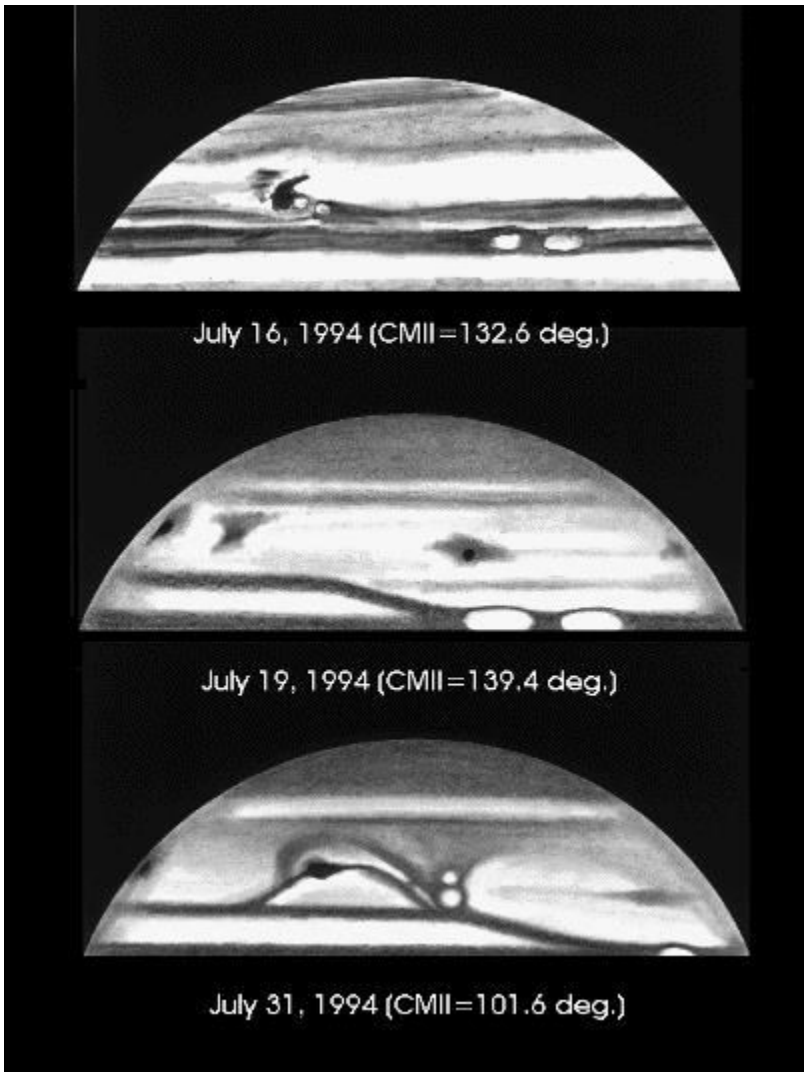

Figure 4 Top sketch by Jeff Beish on July 16, 1994 at 2335 U.T., center sketch by Carlos Hernandez on July 19, 1994 at 0036 U.T., and bottom sketch by Hernandez on July 31, at 0019 U.T., all using 16-inch (41 cm) reflecting telescope at 225 x to 382x.

WHAT HAPPENED TO SL--9 FRAGMENT B'?

Later that evening, July 16th local date, July 17, 1994 Universal date, they began to search for the next SL-9 impact site -- fragment 'B'. By 0335 hours U.T. the first sighting of the B fragment was

seen by Beish and he immediately made a sketch. Hernandez followed shortly there after and made his drawings.

The observers noticed that this new impact site was smaller than the first one; however, appeared to effect the dark zones south of the dark spot, fragment B, and north to the SSTB. As shown in the sketches in in Figures 5 and 6, both observations indicate the impact seemed to push away the dark belts.

Fragment B appears to have disappeared after July 17th. 1994; however, new SL-9 fragment impacts were due to hit Jupiter for the next five days and the observers would have to closely watch out for this small impact site as the week progressed.

Figure 5 Fragment 'B' as sketched by Jeff Beish on July 17, 1994 at 0335 U.T. (CMI = 204°, CMII = 277°).

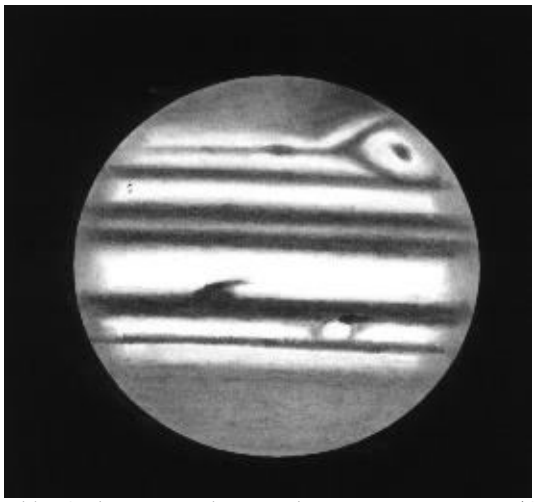

Figure 6 Fragment 'B' as sketched by Carlos Hernandez on July 17, 1994 at 0043 U.T. (CMI = 204°, CMII = 277°).

Later on the night of July 16th the observing team at Beish's home continued recording every detail of the giant planet's appearance until Jupiter went behind the trees in his yard.. Sitting around later talking about the day's adventure and finishing touches on their drawings each observer expressed great pleasure at being among the first people in history to see another celestial body hit a planet in our Solar System.

What else could any amateur planetary astronomer ever want?

We were also fortunate to have several experienced A.L.P.O. members and excellent observers drop by the Beish observatory during this period. Steve O'Meara (Sky and Telescope Magazine)

and well known mirror maker, Dan Joyce, paid a visit to observe and make drawings of the impacts on Jupiter.

Figure 7. sitting in the author's dinnig room, Steve O'Meara and Tippy D'Auria finishing up drawings and notes from observing Jupiter during July 17 – July 31, 1994.

Local A.L.P.O. member and founder of the *Winter Star Party,* Tippy D'Auria and wife, Patty, visited every evening for two weeks and made many valuable observations of the event. (See Figure 1).

Observer's Report of Comet Shoemaker-Levy 9 Impact with Jupiter

By: Tippy D'Auria, A.L.P.O. Member

What did we expect to see when comet Shoemaker-Levy 9 hit the giant planet Jupiter on July 16, 1994? In predicting the apparent effects this comet would have on Jupiter's cloudy surface, this writer made a few assertions. At first, my thoughts were -- that all we would see is a great meteor shower in the atmosphere of Jupiter.

Would the tidal forces of this massive planet break the comet up into only tiny pieces? Would amateur telescopes be large enough to see anything at all? Had observers practiced observing techniques or even observed Jupiter beforehand to familiarize themselves with the rapidly changing features of this planet?

Furthermore, reports by local Jupiter observers indicated that the planet's South Temperate Zone (STZ) and Belts (STB and SSTB) had been active with bright and dark features just days before the impacts were to occur. More than twenty white ovals had been recorded in the STB. With that, would we even notice the impacts at all?

Since I have been primarily a "deep-sky" observer for many years my telescopes are rarely used on the planets. After expressing interest to my A.L.P.O. friends of the possibility of seeing a comet hit Jupiter, their advice was to begin observing the planet months in advance of the event This advice proved valuable -- becoming familiar with Jupiter's ever changing cloud and belt systems is no easy task.

Jeff Beish and Carlos Hernandez practically forced me to make drawings of my observations, even though I lacked artistic talent and experience in making planetary sketches. That didn't matter they told me. What is important is to get what I see down on paper to reinforce my memories of the planet and impacts. They said that a "pretty" drawing was not necessary.

I could not have asked for a better group of observers to help me learn our Solar System than the many A.L.P.O. members located in South Florida. Assembled each night during the later part of July at Jeff Beish's home and observatory, several noted and very experienced planetary observers convened to study the great event. Along with local planetary astronomers Carlos Hernandez and Donald C. Parker, Steven O'Meara of Sky and Telescope Magazine was accompanied by well known Chicago mirror maker, Dan Joyce. They came to observe, make sketches of Jupiter, and see first hand the impacts sights in a first-class telescope.

Well, most of my predictions did not come true. However, we are privileged to have participated in this historical event, something none of us will ever forget! A humbling experience.

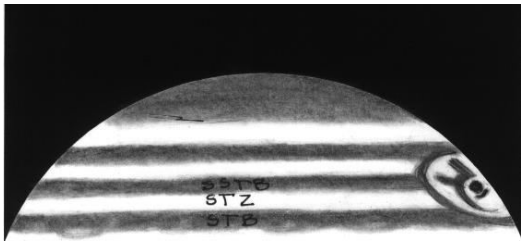

Figure 8. Drawing of impact fragment F (16) by Tippy D'Auria on July 18,1994 at 0239 U.T. (CMII = 34°).

Other Observations

During the following week we received a drawing from Robert Robinson made on July 19th, 0043 U.T. showing fragments E (17), A (21), and C (19) along with the white ovals BC and DE.

A.L.P.O. Jupiter Recorder, Phill Budine, sent a drawing of impact fragments Q (7), H (14), and E (17) with Jupiter's Great Red Spot made on July 21 at 0100 U.T..

Figure 9. Robert L. Robinson on July 19, 1994 at 0043 U.T., (CMI = 55° , CMII = 114°), fragments E (17), A (21), and C (19). White ovals BC and DE shown in STB.

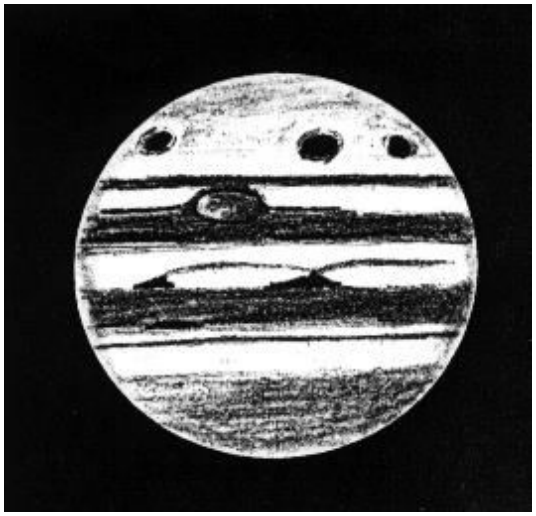

Figure 10. Phillip Budine on July 21, 1994 at 0100 U.T. (CMI = 20°), CMII = 58°) ,showing fragments Q (7), H (14), E (17), and the Great Red Spot (43°W).

On July 22, 1994 between 0010 and 0110 U.T. Beish and Hernandez noted three dark nodules situated on the South South Temperate Belt (SSTB, 45°S) adjacent to the CM. This series of impact sites are, from left to right, fragments U (3), W (2), and K (12). The three impact sites were surrounded by three dark arcs to the south; the inner arc being very dark whereas the outer two were lighter in shad. These arcs may have been produced by ejecta from the fragment explosions. Later, these impact sites were seen connected by dark filaments and merge to some extent forming a complex nicknamed "The Scorpion" by the authors due to it's dark southern arc producing the impression

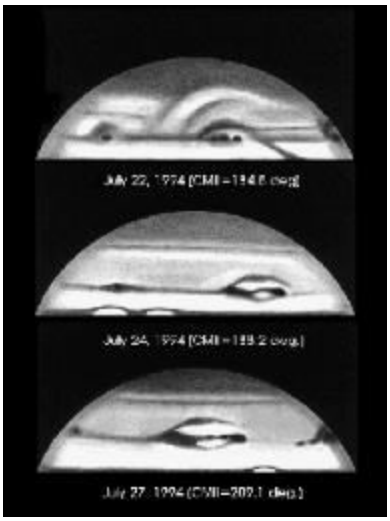

Figure 11. Three sketches made by Hernandez from July 22 to 27 showing the evolution of complex located between 190°-214°W . The top figure on July 22 at 0010 U.T. (CMII=185°) shows impact fragments U, W , and K. Middle sketch on July 24, 0155 U.T. (CMII=188°W) shows further development of complex that now has dark filaments between impact sites. Bottom was made on July 27, 0000 U.T. (CMII=209°W) shows complex enlarged in area with merging impact sites of fragments U and W and a westward (increasing longitude) extension of K .

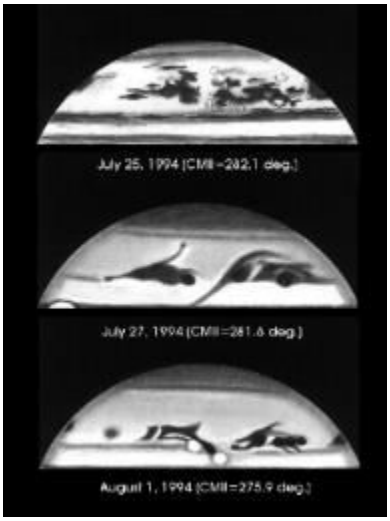

Figure 12. Composite of three figures drawn by Beish and Hernandez from July 16 to 31 showing evolution of fragment A impact site. Top figure by Beish is the discovery sketch made on July 16, 1994 at 2335 U.T. (CMII=133°W) showing dark crescent-shaped impact site. Middle figure by Hernandez on July 19, 0125 U.T. (CMII=139°W) shows fragment A impact site towards the preceding (left) limb. Lightened in appearance and now exhibits a more prominent ray system to the south and to the north. Bottom figure by Hernandez on July 31, 0020 U.T. (CMII=102°W) shows longitude of fragment A impact site but is now not visible and area only has dark filaments projecting from the South South Temperate Belt (SSTB) towards south as well as two small, bright ovals.