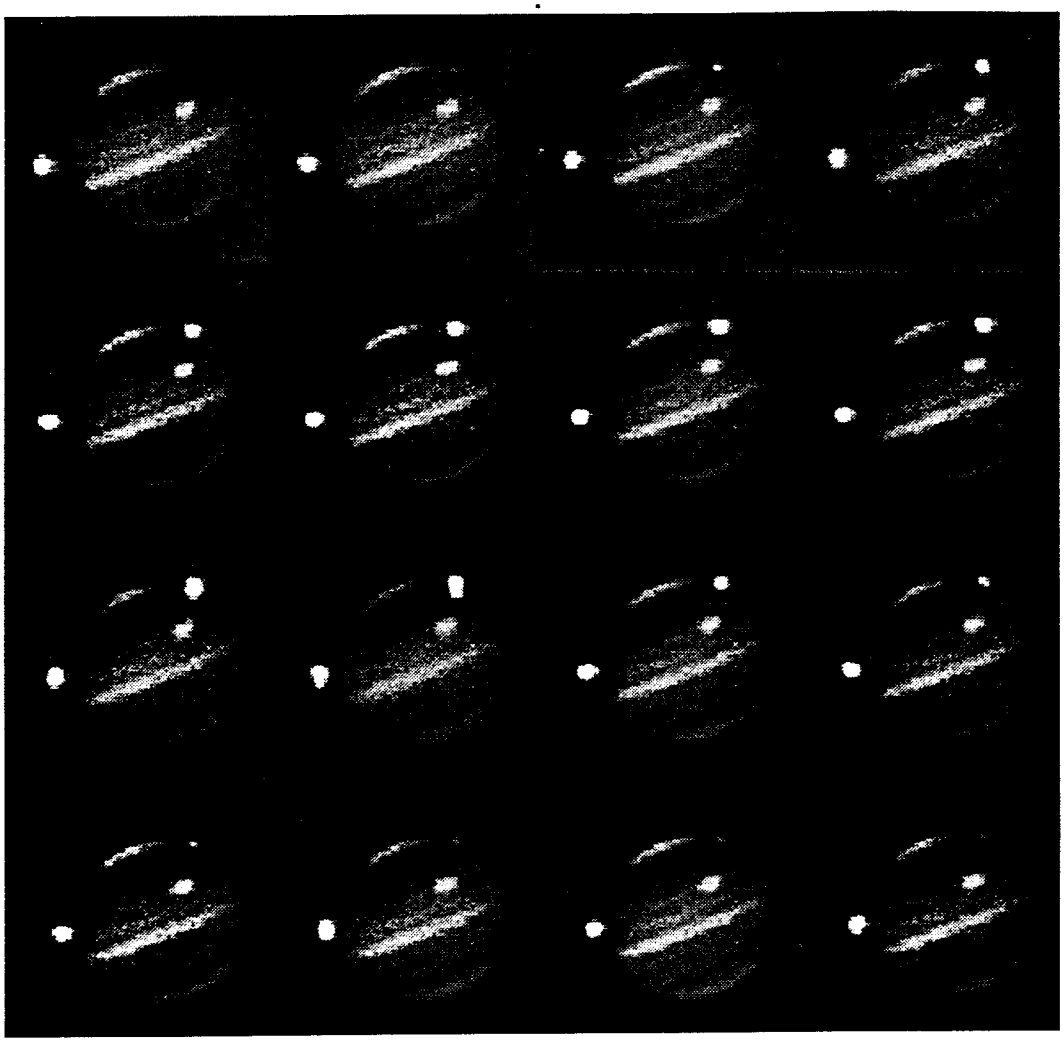
Saskatoon Skies

Volume 24, Number 7 | Summer, 1994



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In This Issue

SUMMER EVENTS

This month's newsletter is a summer special issue on the collision of Comet Shoemaker-Levy 9 with Jupiter. Although I convinced Rick to hold off his articles until September (to get lots of room for pictures), I still need to announce some upcoming events. September's newsletter will also hopefully contain two meetings worth of minutes - that will consume approximately half the newsletter.

The July Public Star Night at Diefenbaker Park on July 8 and 9 was completely clouded (and thunderstormed) out. Not to worry though because we're going to try again on September 9 and 10. Here are the upcoming events:

- **Perseid Star Night**, Thursday August 11, at Rystrom's observatory.
- **Alberta Star Party**, September 2 to 5, in Caroline, Alberta.
- **Saskatoon Public Star Night**, Friday and Saturday night, September 8 and 9, at Diefenbaker Park.
- **September General Meeting**, Monday September 19 in Room A-220, Health Sciences Building, U of S Campus at 8:00 p.m.
- **University Observatory Public Viewing**, 9:30 to 11:30 p.m. Saturday nights in August and 8:30 to 10:30 p.m. Saturday nights in September.

For more information on any of these events phone Rick Huziak at 665-3392. For more information on the university observatory public viewing, phone Stan Shadick at 966-6434.

Location of the Impact Spots

Using the calculations of Paul Chodas of the Jet Propulsion Lab in California, I have computed the System II longitudes of the impact spots. The calculations are accurate to a few degrees; spots on Jupiter tend to drift around a bit anyway. To figure out what spot you have seen in a telescope, compute the System II central meridian using the procedure given on page 139 of the *Observer's Handbook 1994* and work from there. Note that the numerical value of the central meridian visible to us increases with time as Jupiter rotates.

Fragment	Longitude	Fragment	Longitude	Fragment	Longitude	Fragment	Longitude
A	98	F	54	N	348	S	311
B	351	G	322	P2	163	T	57
C	138	H	37	Q2	318	U	195
D	312	K	198	Q1	335	V	70
E	74	L	264	R	323	W	199

Cover Photo - Impact A

This months front cover shows the impact of Fragment A with Jupiter as seen in K-band (2.2 micron) infrared. These images were taken by Dr. Kaz Sekiguchi of SAAO (South African Astronomical Observatory) using a 0.75 m telescope and a PtSi camera. The images were taken at 30 second intervals. The earliest faint signs of the fireball appear at about 20:17-20:18 UT, and at peak brightness it was comparable in brightness to Io. After 10 minutes, the fireball image appears to change shape, becoming elongated along the limb, presumably as the heated plume settles back. The last traces along the limb are visible at least as late as 20:38 UT. The rise in brightness is much faster than the decline.

The time sequence proceeds from top left to bottom right. The images are 30 sec exposures, at intervals of 1 minute, starting at 2017 UT, ending at 2032 UT. South is up and west is to the left. The bright moon is Io, and the Great Red Spot is clearly visible on the surface of Jupiter. The impact produced a flare which rapidly increased in brightness and decayed slowly. This flare is probably from a plume of material which becomes visible above the limb of Jupiter. Rotation probably plays little part in the observed event.

Saskatoon Skies Information

Commercial vendors wishing to advertise in the "Saskatoon Skies" may do so at the following rates: $50.00 per page, $25.00 per half page and $12.50 for business card ads. Individual RASC members and other parties (at our discretion) may advertise items and events for free.
Summer issue deadline is Friday, July 22, 1994. Please have any submissions in to me by then in order to be included in the next issue. Submissions may be in typewritten form or on a floppy diskette (3.5 or 5 inch size and formatted for MSDOS) preferably as ASCII files. Electronic submissions are preferred as it saves me some typing. Mail or bring your submissions to:

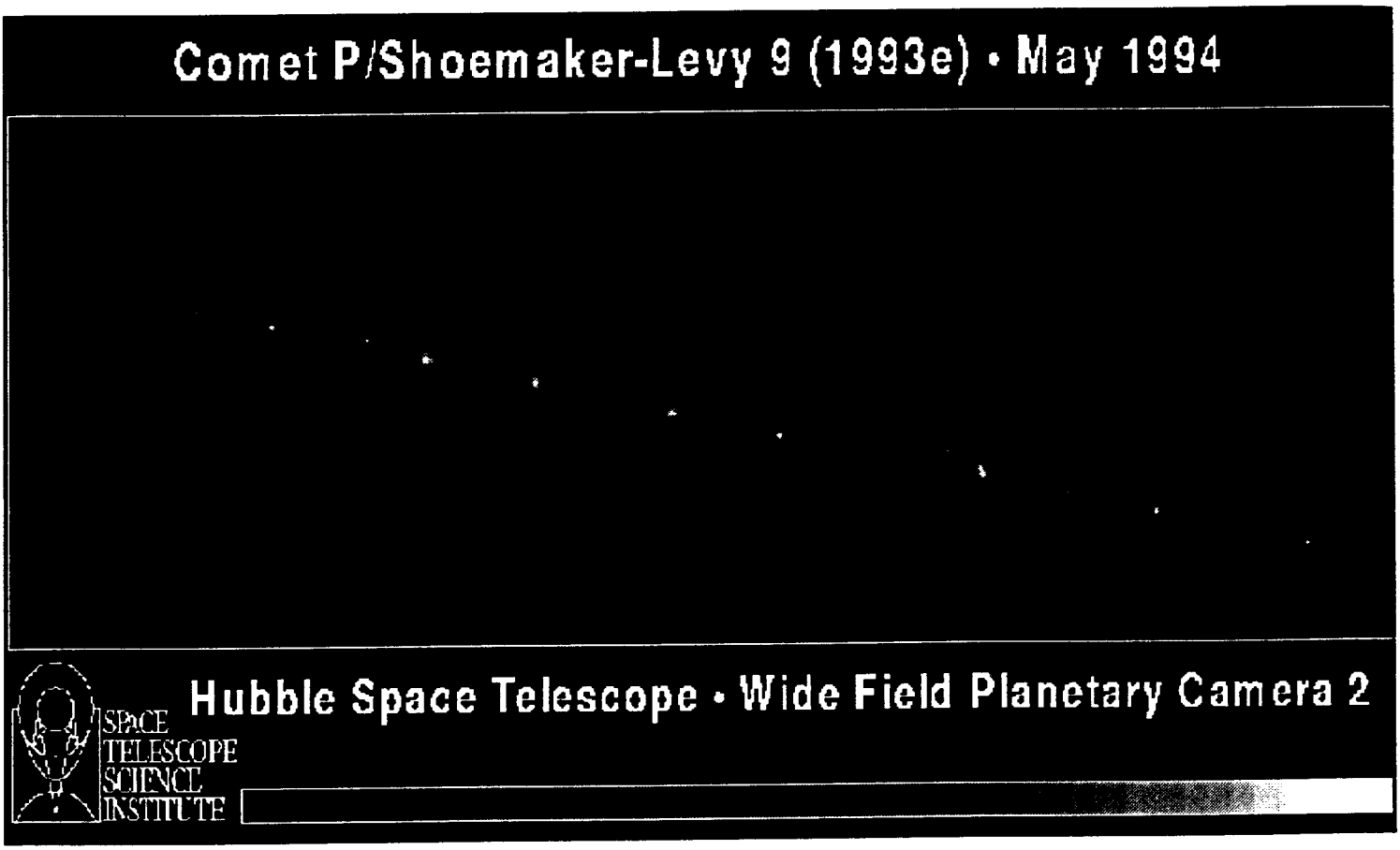
Gordon Sarty
422 Edmund Park,
Saskatoon, Sask.
S7H 0Z4
phone: 374-8803

OR

Saskatoon Centre RASC
Box 317, RPO University
Saskatoon, Sask.
S7N 4J8

E-mail submissions to sarty@math.usask will also be accepted. Saskatoon Skies is a monthly publication of the Saskatoon Centre of the Royal Astronomical Society of Canada.

Hubble's Panoramic Picture Of Comet Shoemaker-levy 9

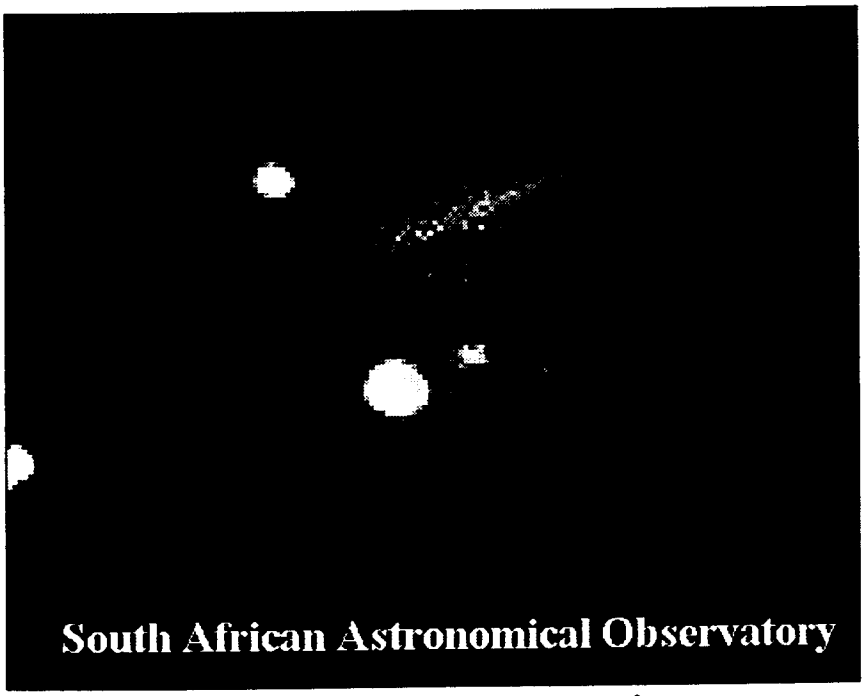


A NASA Hubble Space Telescope (HST) image of comet P/Shoemaker-Levy 9, taken on May 17, 1994, with the Wide Field Planetary Camera-2 (WFPC-2) in wide field mode.

When the comet was observed, its train of 21 icy fragments stretched across 710 thousand miles (1.1 million km) of space, or 3 times the distance between Earth and the Moon. This required 6 WFPC exposures spaced along the comet train to include all the nuclei. The image was taken in red light.

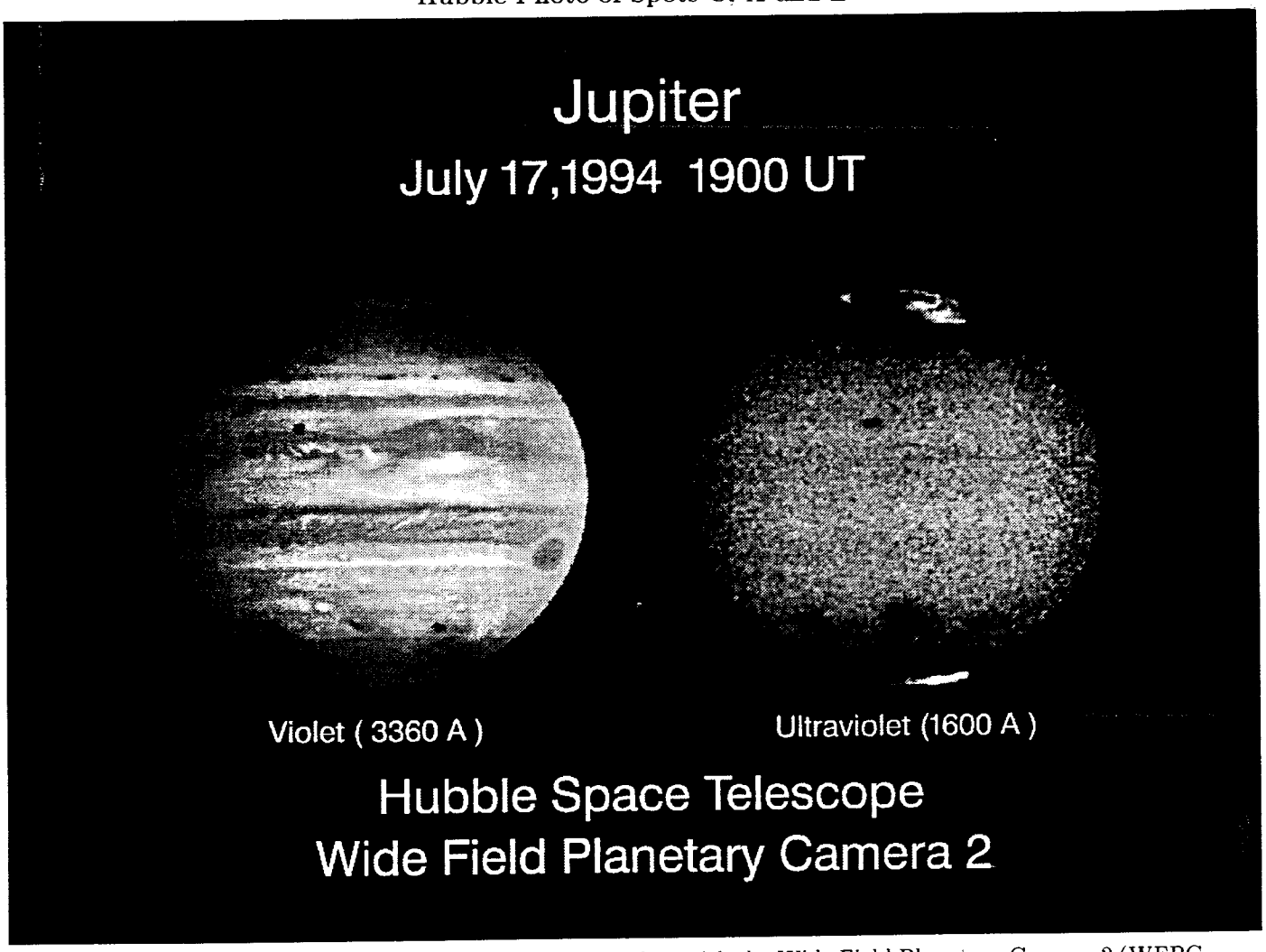
The comet was approximately 410 million miles (660 million km) from Earth when the picture was taken, on a mid-July collision course with the gas giant planet Jupiter.

Credit: H.A. Weaver. T. E. Smith (Space Telescope Science Institute), and NASA



Jupiter at peak of fireball from fragment H on July 18 at 19:45 UT obtained on the 0.75-m telescope at Sutherland by Kaz Sekiguchi in the K band. The exposure time is 30 s. Surface spot from fragment G is near the meridian; Ganymede is near the limb and Io at edge of the frame.
JWM

Hubble Photo of Spots C, A and E



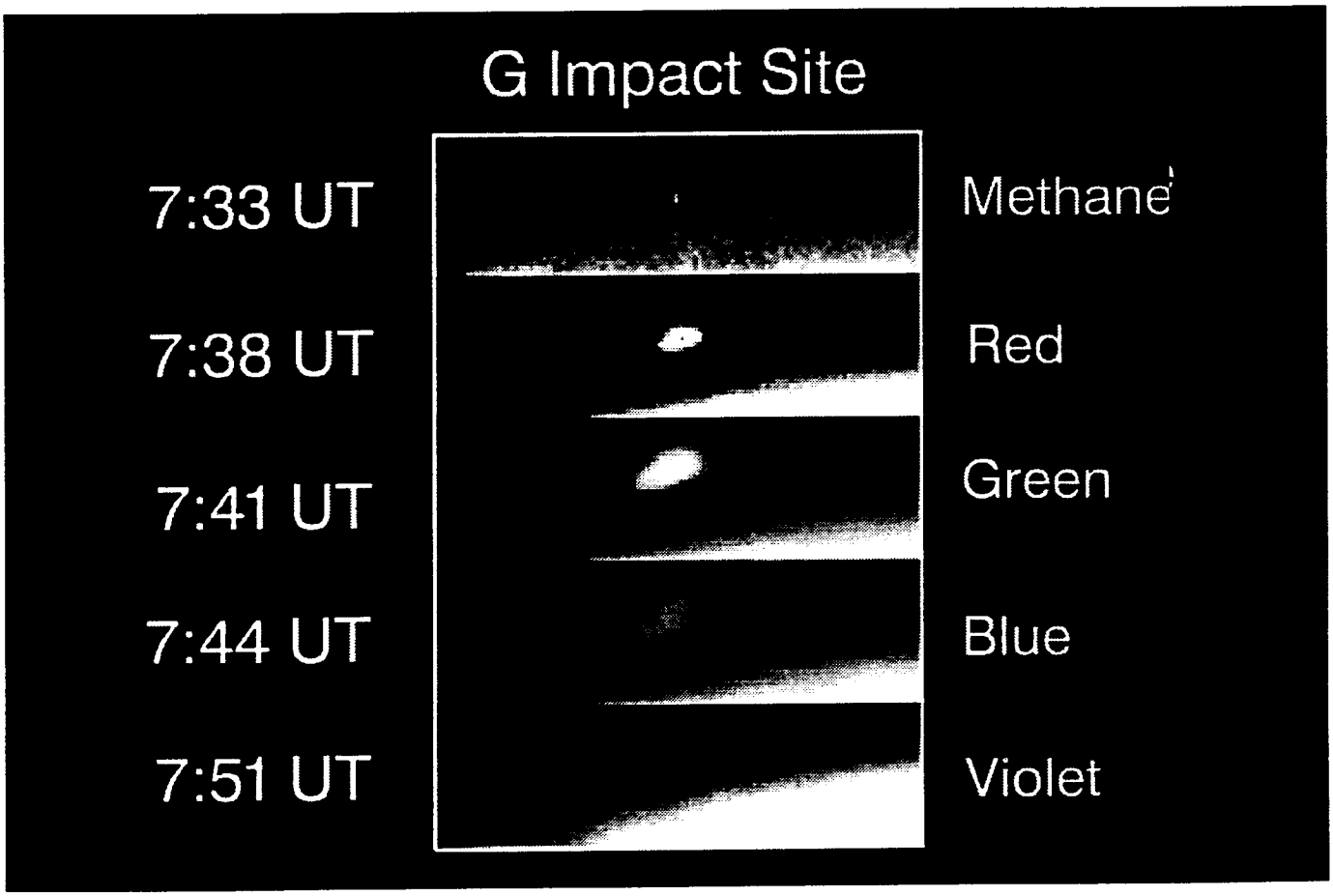
Blue and far-ultraviolet (FUV) images of Jupiter taken with the Wide Field Planetary Camera-2 (WFPC-2) on NASA's Hubble Space Telescope show how the appearance of the planet and of comet Shoemaker-Levy-9 impact sites differ at these two wavelengths (1400-2100 and 3100-3600 Angstroms). The images, taken 20 minutes apart on 17 July 1994 (around 19:00 UT), show the impact sites on the south hemisphere, from left to right, of comet fragments C, A and E about 12, 23, and 4 hours after each collision. Jupiter's satellite Io is seen crossing above the center of the disk.

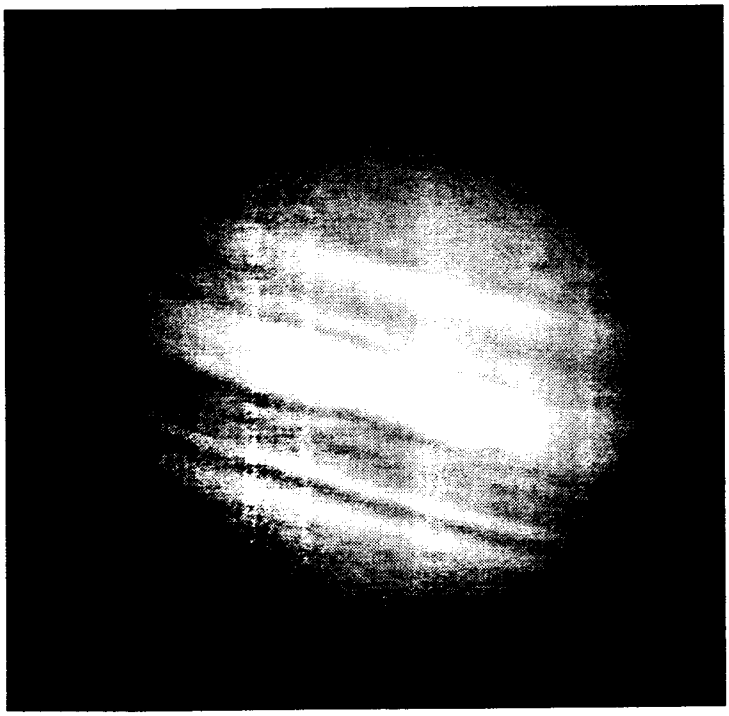
In both colors the planet is seen in sunlight reflected by the atmosphere. The visible light penetrates to the top of the cloud decks, but the FUV light only reaches the stratosphere and higher altitude levels (100's of kilometers above the cloud tops). In the FUV, the signatures of trace amounts of ultraviolet absorbing gases and haze in the Jovian stratosphere and higher levels are observed. Around the poles the atmosphere appears dark due the presence of hazes, and in addition, ultraviolet auroral emissions are observed. These emissions are produced when energetic charged particles from the magnetosphere collide with molecular hydrogen in the upper atmosphere. Low-contrast banded structure is seen across the disk in the FUV. The salt-pepper appearance of Jupiter in the FUV is due to the darkness of the planet at this wavelength.

In the visible image, the impact sites appear as localized dark spots with diffuse halos. In the ultraviolet the impact regions appear darker and more extended, because the FUV is more sensitive to smaller amounts of particles, and/or that the horizontal winds in the upper atmospheric levels may be faster. The dark appearance is due to presence of enhanced amounts UV absorbing molecules, scattering hazes and dust. This material should be combination of gases from Jupiter's lower atmosphere as well as comet volatiles and impact by-products upwelled and deposited into the stratosphere and thermosphere. Material should also have been deposited from ablation of the fragments and dust during entry. Tracking the motions with WFPC-2 FUV images of the dark comet fragment "clouds" throughout the impact period should reveal for the first time the magnitude and direction of the high altitude winds on Jupiter. The Jovian auroral emissions will also be monitored with both WFPC-2 and the Faint Object Camera (FOC) to determine if the associated processes are affected by the comet's passage through the magnetosphere or changes in the upper atmosphere.

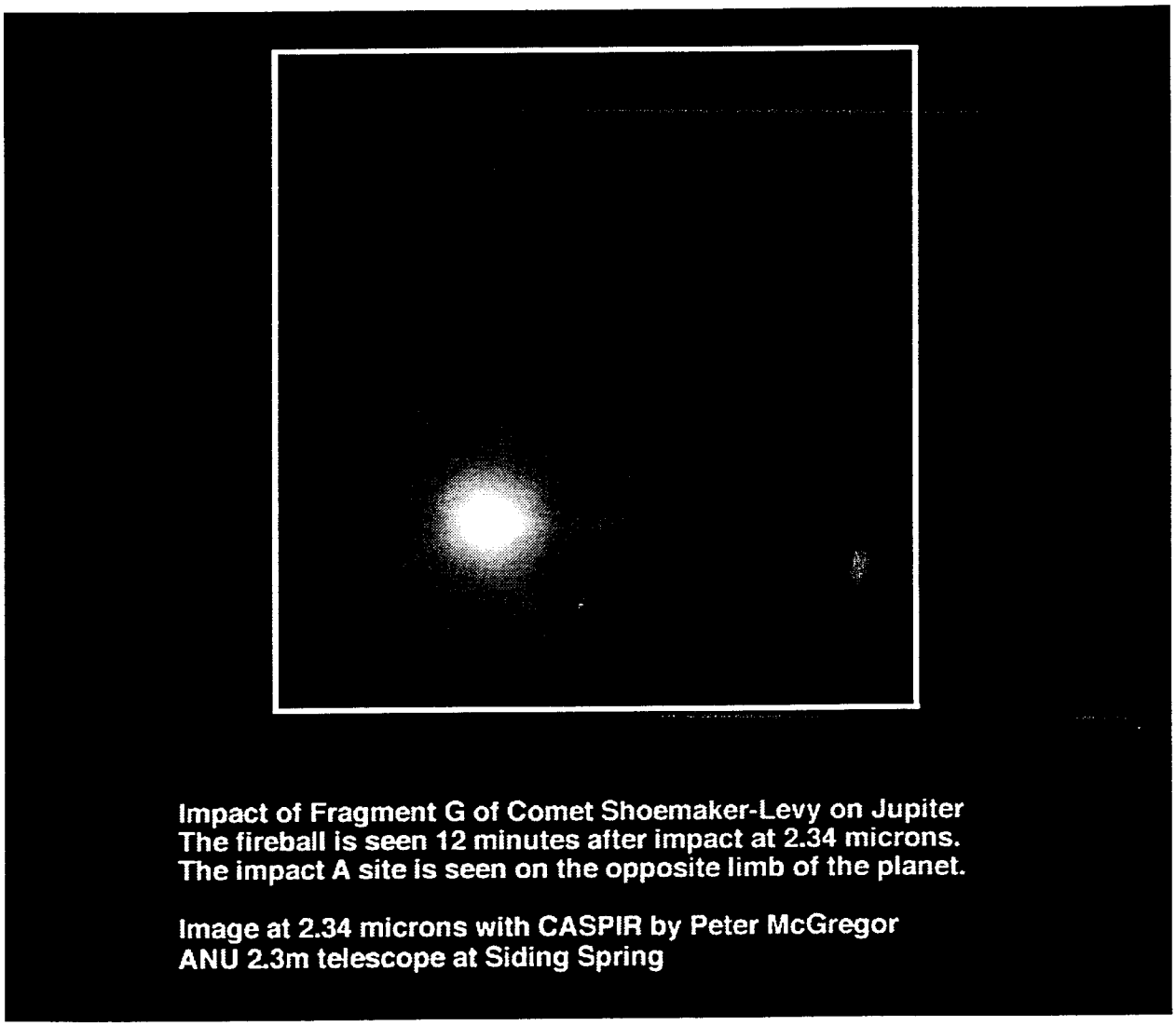
Credit: Hubble Space Telescope Jupiter Imaging Team

HST Photo of Plume from G Impact



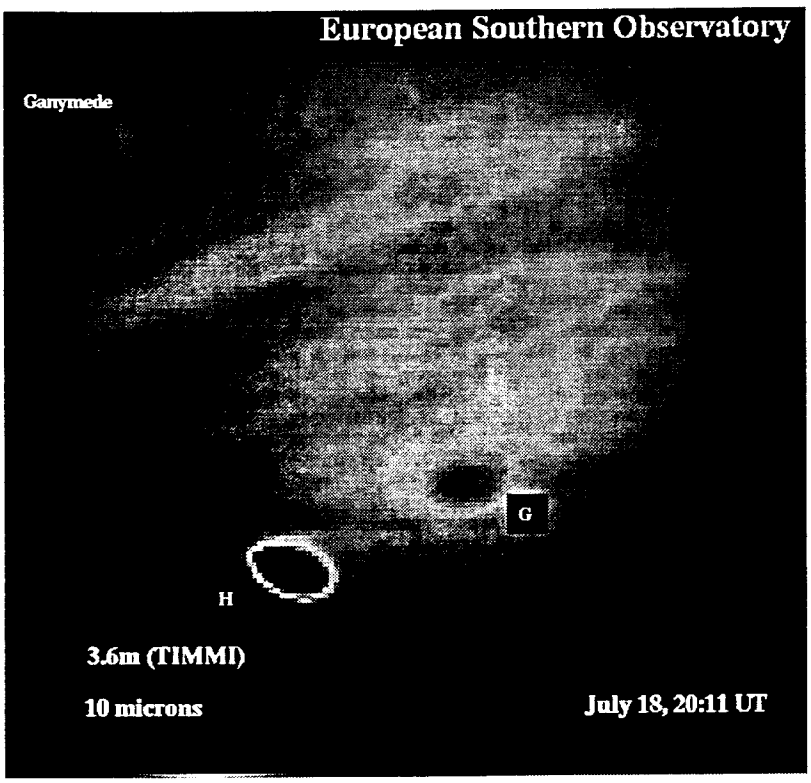


Speckle imagery of Jupiter taken at the Lick Observatory 120 inch telescope.
This image shows the site of impact G, comet Shoemaker-Levy 9, at 04:56 universal time (UT) July 19, 1994.
Impact G was the largest and most dramatic at the time. At a wavelength of 550 nm, the impact point shows a dark core (approx 1.7 arc-sec in the narrow dimension) surrounded by a ring-like feature (approx 4 arc-sec in diameter). The dark core shows distinct sub-structure, and the ring is brighter on one side than on the other.
In this image, the south pole is up and east is to the left, so that the planet is rotating from left to right.
The imaging parameters were: Wavelength: 550 nm, Bandwidth: 40 nm. Plate scale: 0.063 arc-sec/pixel. Size: 750 x 750 pixels (approx 47 arc-sec x 47 arc-sec).
The image was reconstructed from 40 individual short-exposure speckle frames (exposure times of 200 ms and 300 ms, respectively) via a bispectral speckle imaging algorithm.
Observers: Claire Max, Don Gavel, Erik Johansson, LLNL; Mike Liu, UC Berkeley; Bill Bradford, UC Santa Cruz.



Impact of Fragment G of Comet Shoemaker-Levy on Jupiter
The fireball is seen 12 minutes after impact at 2.34 microns.
The impact A site is seen on the opposite limb of the planet.

Image at 2.34 microns with CASPIR by Peter McGregor
ANU 2.3m telescope at Siding Spring

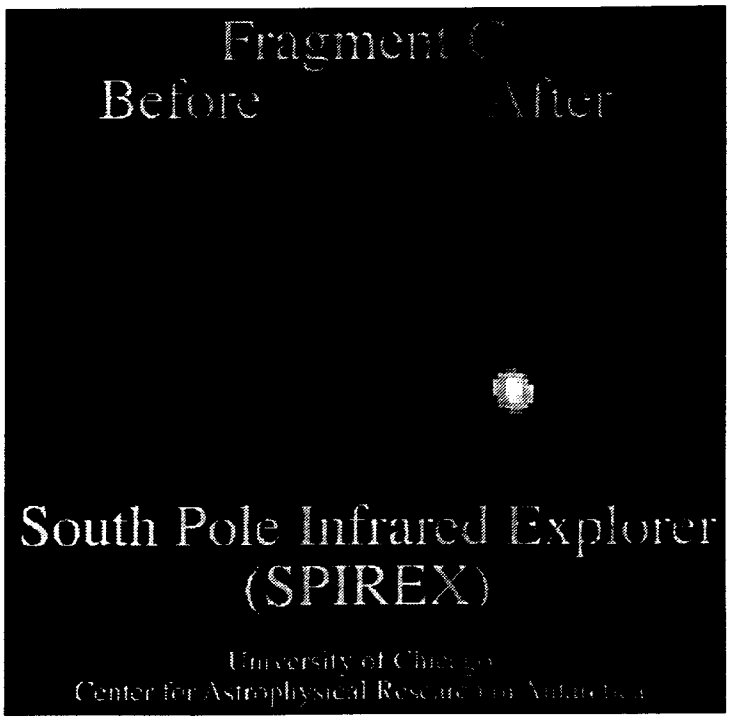


Dramatic Impact of H-fragment Observed at La Silla

This image was obtained with the TIMMI instrument at the ESO 3.6-metre telescope on July 18, 1994, 20:11 UT. It shows the rising plume above the impact site of fragment H of comet Shoemaker-Levy 9. The image was made in the 9.1 - 10.4 micron band in the far-infrared region.

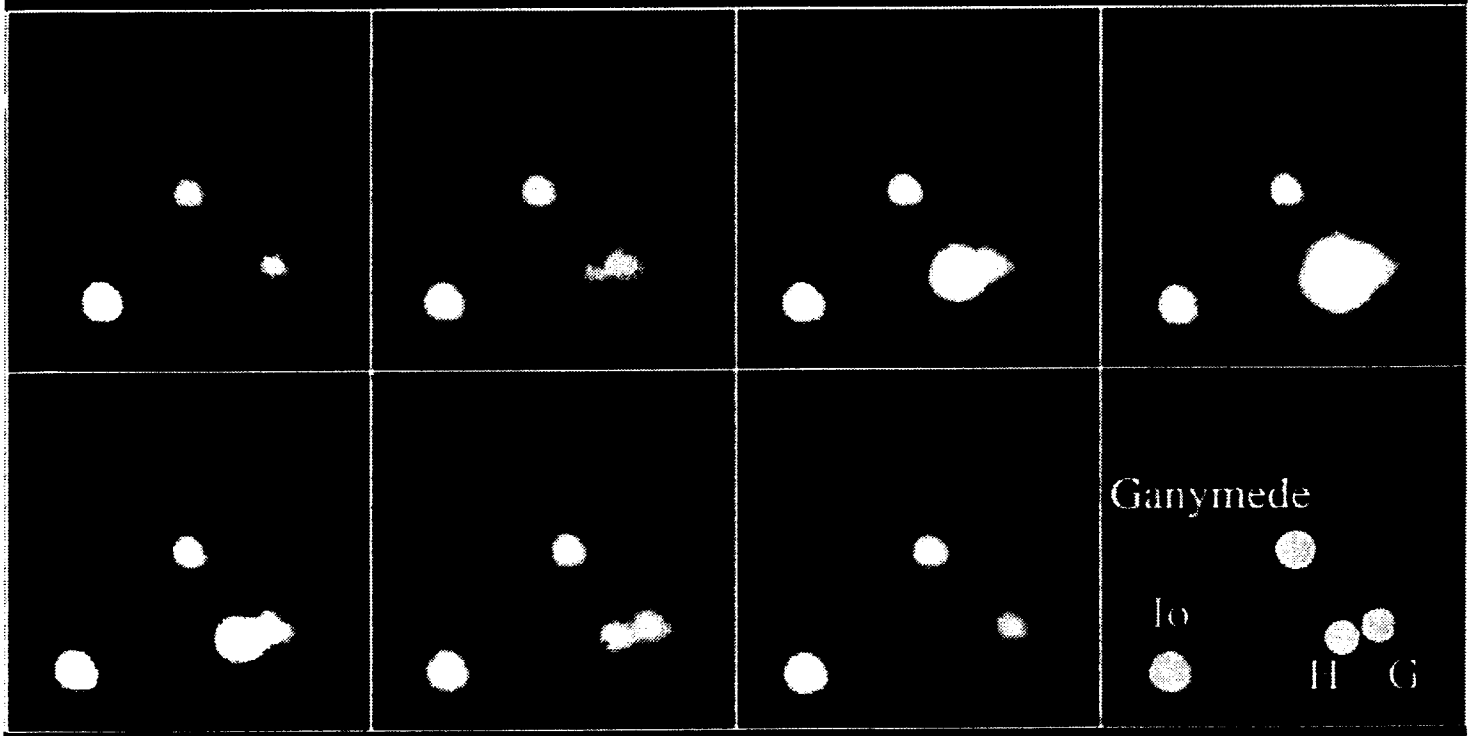
The surface brightness of this plume was about 50 times that of the Jupiter disk. The temperature was measured as more than 300 K.

The observers were Tim Livengood (NASA), Ulli Kaeufl (ESO), Benoit Mosser and Marc Sauvage (Observatoire de Paris-Meudon, France).



Plume from explosion of fragment C of Comet Shoemaker-Levy 9 as seen by the South Pole Infrared Explorer (SPIREX). These are 2.36 micron near infrared data. Images are shown before impact, and 4 minutes later. These observations were performed by University of Chicago and Center for Astrophysical Research in Antarctica (CARA) Astrophysicists Mark Hereld, Hien Nguyen, Bernard J. Rauscher, and Scott A. Severson.

Comet Shoemaker-Levy 9 Fragment H Collides with Jupiter



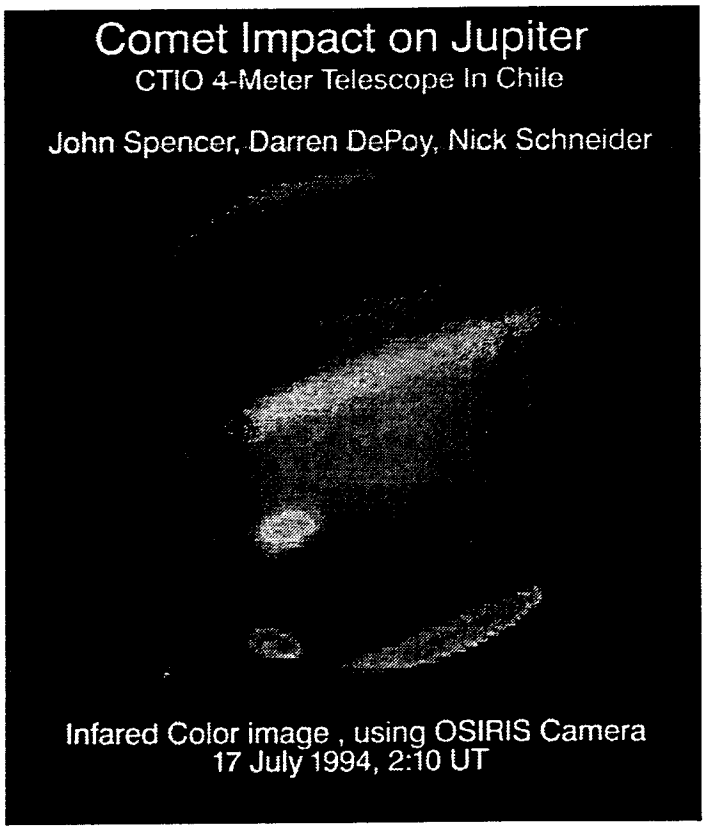
These near-infrared (2.36 micron) images were taken by the South Pole Infrared Explorer telescope (SPIREX) beginning at 2:21 p.m. (Chicago), 18 July 1994, at five-minute intervals.

Jupiter's moons Io (far left) and Ganymede (top left) are visible. The impact site of Fragment G has rotated back into view and is visible as a bright spot near the planet's southern pole.

SPIREX, built and operated by scientists at the University of Chicago, is funded by the National Science Foundation. The SPIREX team includes Mark Hereld, Hien Nguyen (at the South Pole), Bernard Rauscher and Scott Severson.

Image of Jupiter with the Hubble Space Telescope Planetary Camera. Eight impact sites are visible. From left to right are the E/F complex (barely visible on the edge of the planet), the star-shaped H site, the impact sites for tiny N, Q1, small Q2, and R, and on the far right limb the D/G complex. The D/G complex also shows extended haze at the edge of the planet. The features are rapidly evolving on timescales of days. The smallest features in this image are less than 200 kilometers across. This image is a color composite from three filters at 9530, 5550, and 4100 Angstroms.
Credit: Hubble Space Telescope Comet Team

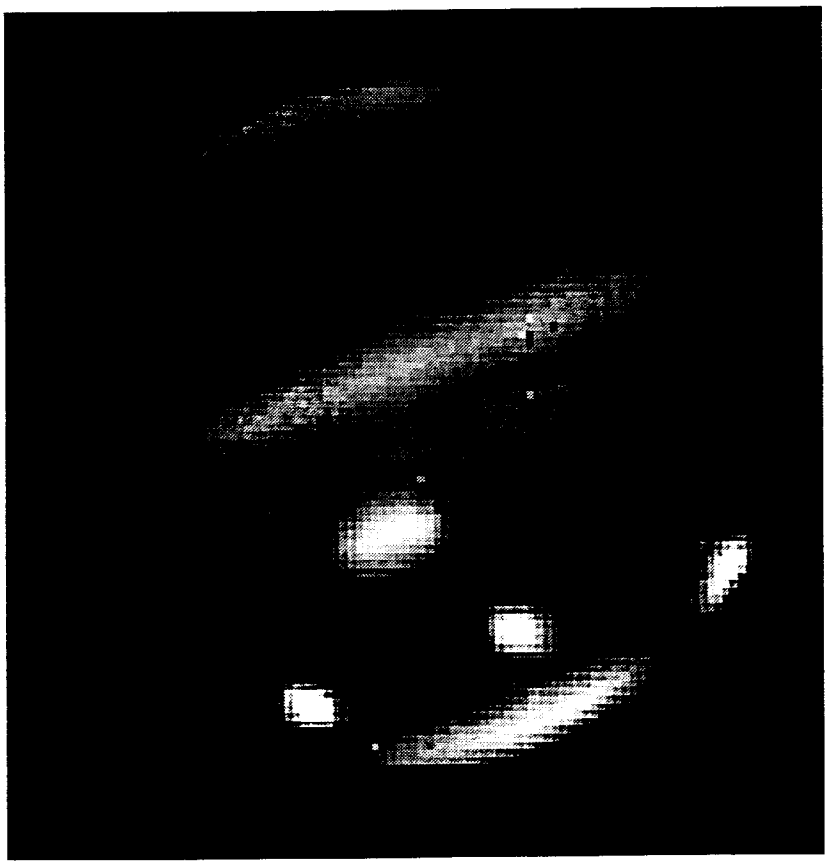
This is a 2.07 micron image of Jupiter taken on the NASA Infrared Telescope Facility, Mauna Kea, Hawaii, at 08:54 on July 21, 1994. The image was taken in a four second exposure using the IRTF's facility near infrared camera, NSFCAM.
Io, the closest of the jovian moons, can be seen crossing the planet in the northwest of the image (top right). The Great Red Spot is visible in the south east of the planet.
At the collision latitudes, the impact due to Fragment Q is just setting on the west. Just to the east of it, the R Fragment impact site shows up very brightly. Another four impact sites form a chain of spots behind R (N.B there is an additional fainter spot which may not be clearly visible).
Steve Miller and Mark Shure for the NASA IRTF Comet Science Team



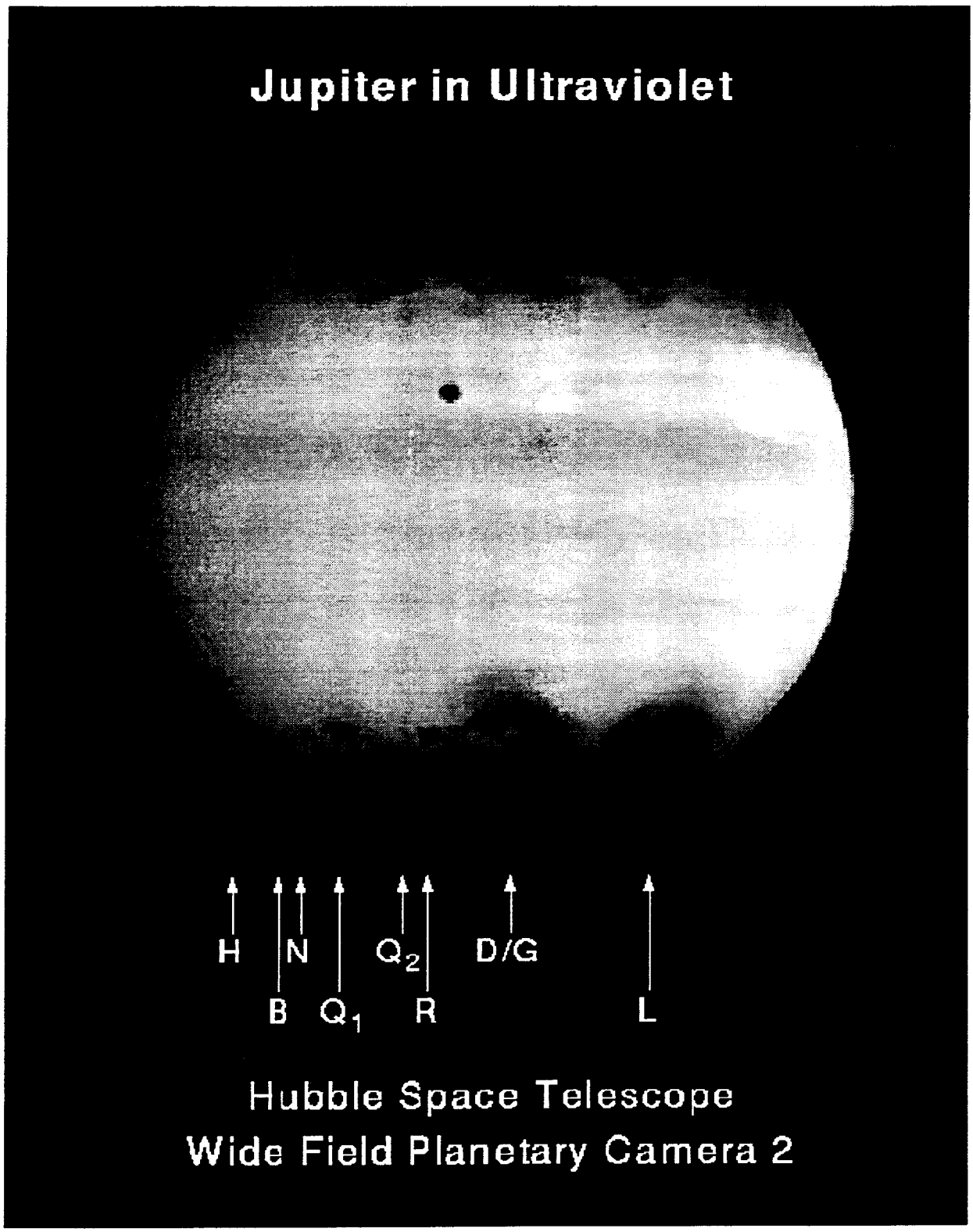
This true-color IR image shows the aftermath of the impacts of several of the fragments of Shoemaker-Levy 9 with Jupiter. The image is a composite of three IR filters (2.3, 1.7, and 1.58 microns) which are shown here are red, green and blue.
The impact sites are the small red/orange spots at high southern latitudes: a bright one (A) visible rising on the limb to the left, and a much fainter one (D) setting on the right. The impact sites are clearer an an accompanying greyscale image, and are explained in its caption. Most of Jupiter's disk appears blue because is it brightest in the 1.58 micron filter where methane absorption is not significant. The great red spot actually appears green in this composite, as it quite prominent in the 1.7 micron wavelength range.

Jupiter's poles are capped with a high haze, appearing orange in this image. The polar 'hoods' are high enough to reflect sunlight at in these long-wavelength methane absorption bands.

Technical details: Images taken between 2:06 and 2:18 UT on July 18, 1994, with the Ohio State Infrared Imaging Spectrometer (OSIRIS) at the 4-meter telescope of the Cerro Tololo Inter-American Observatory in Chile, by John Spencer (Lowell Observatory), Darren DePoy, Jay Frogel (Ohio State University), and Nick Schneider (CU/LASP).



Jupiter on July 19, 1994 CST. This image was made with ROKCAM at the University of Texas McDonald Observatory 2.7 meter telescope on Mt. Locke. Taken at 2.12 microns (an absorption band of molecular hydrogen) on July 20 4:20 UT (July 19 11:20pm CDT), this image shows impact sites A, E/F, H, and D/G (left to right). As displayed, north is on top and east on the left. This picture is somewhat amusing if turned upside down.
Made by Dr. Yongha Kim (Univ. of MD), Dr. Beth Clark (Univ. of TX) and Dr. Bill Cochran (Univ. of TX).



Ultraviolet image of Jupiter taken by the Wide Field Camera of the Hubble Space Telescope. The image shows Jupiter's atmosphere at a wavelength of 2550 Angstroms after many impacts by fragments of comet Shoemaker-Levy 9. The most recent impactor is fragment R which is below the center of Jupiter (third dark spot from the right). This photo was taken 3:55 EDT on July 21, about 2.5 hours after R's impact. A large dark patch from the impact of fragment H is visible rising on the morning (left) side. Proceeding to the right, other dark spots were caused by impacts of fragments Q1, R, D and G (now one large spot), and L, with L covering the largest area of any seen thus far. Small dark spots from B, N, and Q2 are visible with careful inspection of the image. The spots are very dark in the ultraviolet because a large quantity of dust is being deposited high in Jupiter's stratosphere, and the dust absorbs sunlight. Scientists will be able to track winds in the stratosphere by watching the evolution of these

Credit: Hubble Space Telescope Comet Team