NO. 188 THE RED POLAR CAPS OF IO

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ABSTRACT

An excellent series of Jupiter photographs obtained on August 9, 1973 showed Io to have red-brown polar caps, with the South Cap substantially larger than the North Cap. Reproductions are shown in the color Plate. The polar caps stand out by the color contrast against a white-bluish zone of Jupiter. When projected against a brown belt, only the truncated brighter equatorial region of the satellite is seen. Some 1968 images of Io also show the color of the polar caps directly.

Jupiter has been routinely photographed by the Lunar and Planetary Laboratory since October 1965 to the present. During this interval, the four Galilean satellites are frequently recorded in transit across Jupiter's disk. Io is most

often recorded due to its proximity to Jupiter. Since 1972, as an aid to more accurate longitude measures of Jupiter's clouds, Io has been routinely photographed at Inferior Geocentric Conjunction (IGC). The planet's geometrical phase defect is exaggerated on photographs, e.g. in the UV, by less-than-normal limb brightening at the terminator and more-than-normal at the opposite limb. With Io measured relative to the East and West limbs at IGC, the linear displacement from the measured center can be converted to a correction, applied in calculating the longitudes of clouds.

There are quite a few images of Jupiter in the LPL collection which show a non-uniform disk of Io. The best of these are reproduced in Plate I and Figures 1-7. Only images with Io in transit reveal surface markings provided the seeing is excellent and the background uniform. Photographed against a dark sky, Io's markings are not recorded with our cameras - just the yellow color of the satellite as a whole. Prior to August 1973, our color photographs had suggested that the polar regions of Io were simply dark. Both caps blend in well with the generally warm yellow, brown, and red tones of Jupiter's clouds. The caps are recorded as dark in all wavelengths used in our black-and-white photography. The equatorial region is recorded as yellow on color films and as very bright in the photographic infrared. In UV and blue light, the satellite as a whole is dark; but the slight non-circularity of these images suggests the equatorial region is still slightly brighter than the polar caps.

A combination of fortunate circumstances occurred on August 9, 1973, whereby the polar caps were recorded and are easily discernible as being red in color. The seeing was excellent; Io was well placed from the CM and limb; and the background of Jupiter was bluish-white. IGC occurred at 0605 UT, with Io appearing as an orange, ill-defined spot. Some 35 minutes later the background of Jupiter was reduced to more nearly that of Io. At these times (2 per transit) adjacency effects in the photographic image of Io are minimal. From 0640 to 0641 UT, 27 images of Jupiter were taken of which all but two or three, of poorer quality, easily show the dark, red polar caps and the yellow equatorial region. The best images are reproduced in color in Plate I. The 1968 and 1973 color images show the South Polar Cap to be larger than the North. Of our five superior-quality color rolls, three show a variable width (in longitude) of the equatorial region. It appears to be widest near about 200° of Io longitude, becoming narrower near the West and East limbs. The infrared photographs of Io show the equatorial region as very bright, narrow, and to have an essentially constant width in longitude (see Figs. 3, 5, 6). Figure 8 is my interpretation of LPL color and infrared photographs of Io.

Legends for Plate I on next page

a. 1968 Jan 25 08:28:16 UT
High Speed Ektachrome

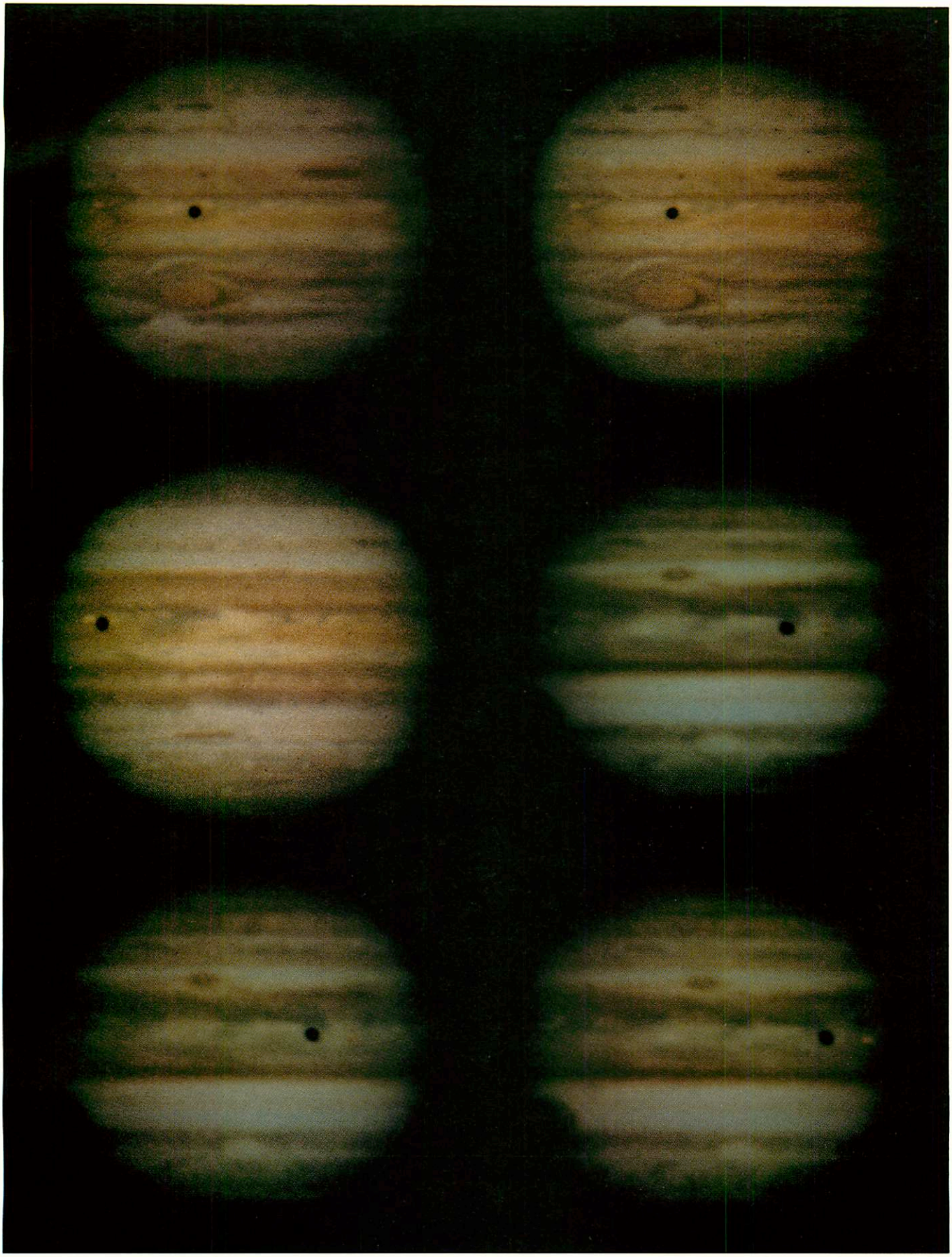
b. 1968 Jan 25 08:28:58 UT
High Speed Ektachrome

c. 1968 Feb 17 08:06:41 UT
High Speed Ektachrome

d. 1973 Aug 9 06:40:19 UT
Ektachrome (comp. of 4)

e. 1973 Aug 9 06:40:52 UT
Ektachrome (comp. of 2)

f. 1973 Aug 9 06:56:10 UT
Ektachrome (comp. of 8)



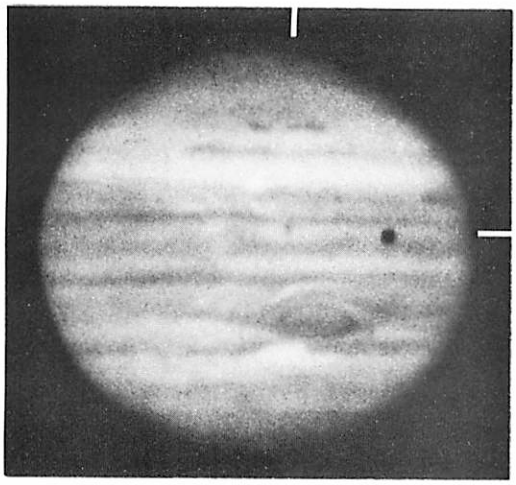


Fig. 1 1968 Jan 25 0925 UT,blue fr.color

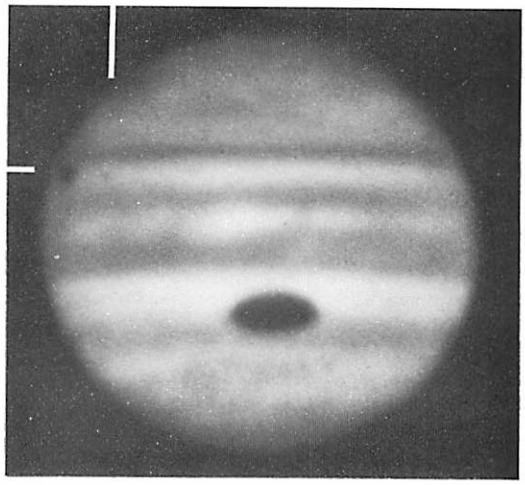


Fig.2 1971 Jun 1 0603 UT,blue fr.color

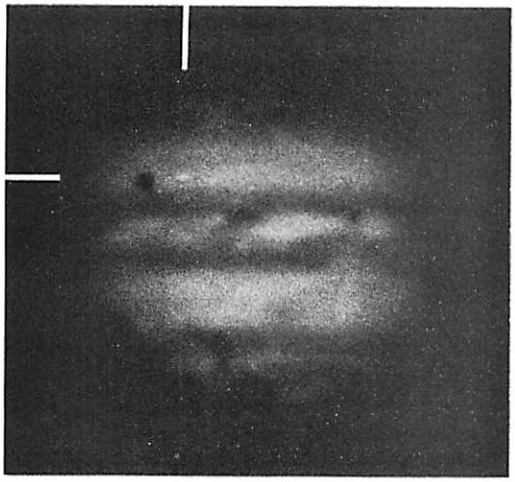


Figure 3 1971 Jun 1 0628 UT, IR

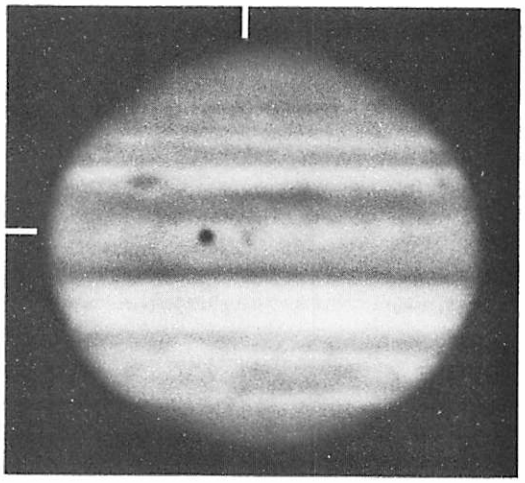


Figure 4 1973 Aug 9 0559 UT, blue

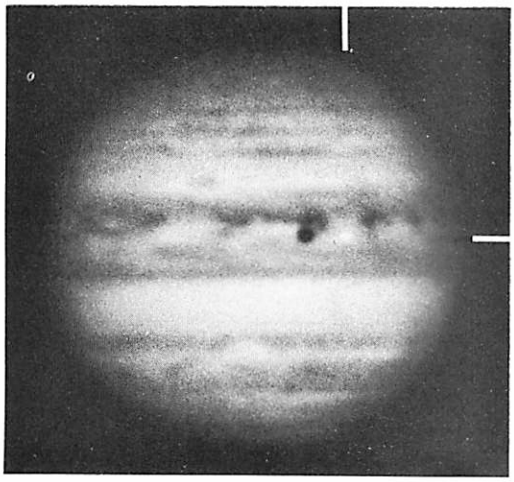


Figure 5 1973 Aug 9 0634 UT, IR

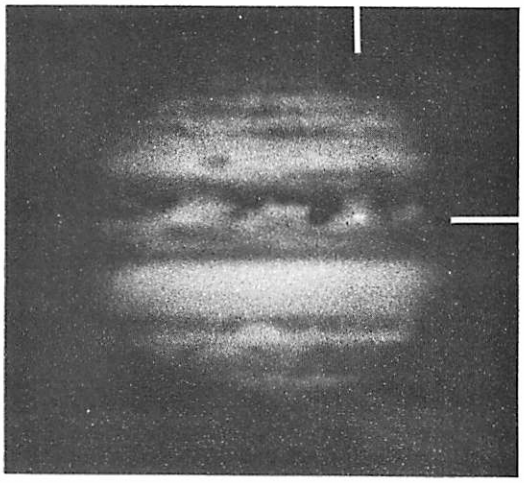


Figure 6 1973 Aug 9 0634 UT, IR

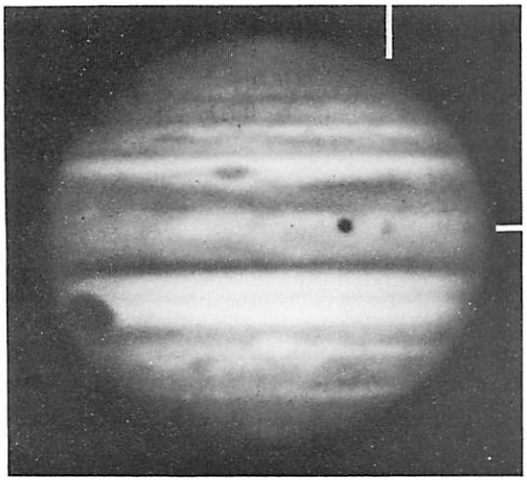


Figure 7 1973 Aug 9 0641 UT, blue from color

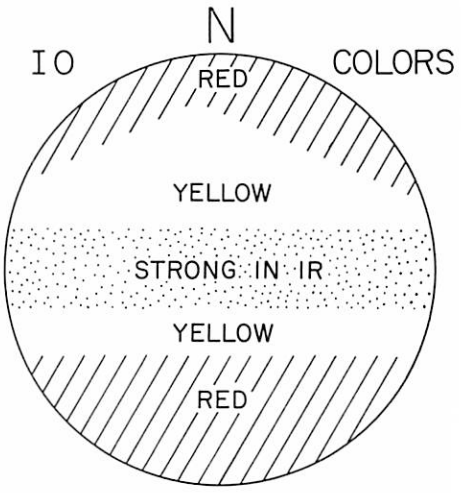


Figure 8 Regions of maximum reflectance at wavelengths indicated

The CM of Io was calculated from the following formula:

$$CM\ Io = 180° + i + 0.^{\circ}14\ t$$

where i is phase angle of Jupiter, + before opposition, - after; and t is minutes before (-) or after (+) IGC. These Central Meridians are listed in Table I.

TABLE I

Date	UT	IGC	Δt	i	CM Io
68 Jan 25	0828	0919	-51^{m}	+5.°3	178°
Jan 25	0829	0919	-50	+5.3	178°
Jan 25	0925	0919	+ 6	+5.3	186°
68 Feb 17	0807	0856	-49	+1.0	174°
71 Jun 1	0603	0651	-48	-2.0	171°
Jun 1	0628	0651	-23	-2.0	175°
73 Aug 9	0559	0605	- 6	-2.0	177°
Aug 9	0634	0605	+29	-2.0	182°
Aug 9	0641	0605	+36	-2.0	183°

The times at which Io most nearly matches the background in intensity at visual wavelengths varies with its CM distance on Jupiter and the intensity of the background. Presently these times are 30 to 40 minutes before and after IGC. Much of Jupiter's Equatorial Zone is presently whiter than in 1972. The red caps are also readily apparent with Io seen in projection against a normally white zone such as the NTrZ (see Fig. 2).

It appears that an ideal instrument for further investigation would be an area scanning photometer or spectrophotometer with a slit no wider than 1/5 arc sec in width. Here, however, the satellite may be more easily studied against a dark sky. Photographic studies appear to be more fruitful with Io in transit. Because of the proximity of Io to Jupiter and the near 12° maximum phase angle of Jupiter, Io can be seen through a total of about 44° of orbital longitude during an apparition and still be seen in transit.

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