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Mars Observations in 2001. Part Ⅲ

— On Spontaneous Sun-Glint Phenomena at Edom in June 2001 —

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(Abstract) We deal here with one of the most remarkable bright spot phenomena on the Martian surface observed in 2001, though this is not the observation which was possible for us to observe: This phenomenon was only observable at a US region. We however touch upon this sun-glint phenomenon and state our consideration as Part III because this belongs to one of the most important observations made in 2001.

Keywords : flares on Mars, sun-glint phenomena, Edom

1 Phenomenon

We received the following amazing news by email from Donald PARKER on 7 June 2001 GMT to our surprise: We had known the plan itself to detect some flares from the Edom area because it was predicted by Thomas DOBBINS and William SHEEHAN in the *Sky and Telescope* magazine (Ref. 1), but it was not a kind of phenomenon which was rigidly assured like the motion of celestial bodies. Here we shall cite PARKER's email because it summarises concisely the situation:

Date: Thu, 7 June 2001 08:54:27 +0100
From: Donald Parker
Subject: Edom Brightening

Dear Masatsugu:
I am pleased to report that after two uneventful nights of observing our team here in the Florida Keys detected significant brightness fluctuations over Edom between 06:40 and 07:30 UT on 7 June, 2001 UTD. Our observing team consisted of Tippy and Patty D'Auria; David Moore; Rick Fienberg, Tom Dobbins, and Gary Seronik of Sky and Telescope Magazine, and me. Instruments included two six-inch Newtonian reflectors and a Meade 12-inch SCT used in conjunction with a monochrome video camera. A perceptible brightening of Edom was noted around 06:35 UT. By 06:40 UT pronounced pulsations in brightness were evident. These events occurred at roughly 10 to 15 second intervals, with brightness maxima of approximately 3 seconds duration that could not be attributed to atmospheric turbulence. These dramatic variations in brightness were simultaneously detected by visual observers at the eyepieces of the 6-inch Newtonians and by those viewing the video monitor. It is notable that they could not be seen with an 85mm refractor.

Further details and images extracted from the videotape will be forthcoming in the near future. Meanwhile, I would be grateful if you would alert other observers to the possibility of repeating these observations, as calculations suggest that the optimum Sun-Earth-Mars geometry for specular reflections at Edom will occur on 8 June UT. Best regards,

Don PARKER

We also received another email from PARKER on the following day as follows:

Date: 8 June 2001 21:49 +0100
From: Donald Parker

We again observed Mars from the Florida Keys this morning (8 June 2001 UTD) from 05:40 UT to 08:36 UT. There appeared to be two peaks in brightening phenomena around Edom. The first was a series of short-lived (3-5 second) brightening observed both visually and via video between 07:00 and 07:20 UT. Mars' altitude was 35 degrees. These were quite pronounced and were similar in frequency to those of 7 June. The second group of events occurred between 07:53 and 08:24 UT (altitude = 26 degs), when a series of small but frequent brightness variations were detected.

In general, the events of this morning displayed the same intensity but less frequency than those of 7 June.

Observers included Dan Troiani, Tippy D'Auria, Scott

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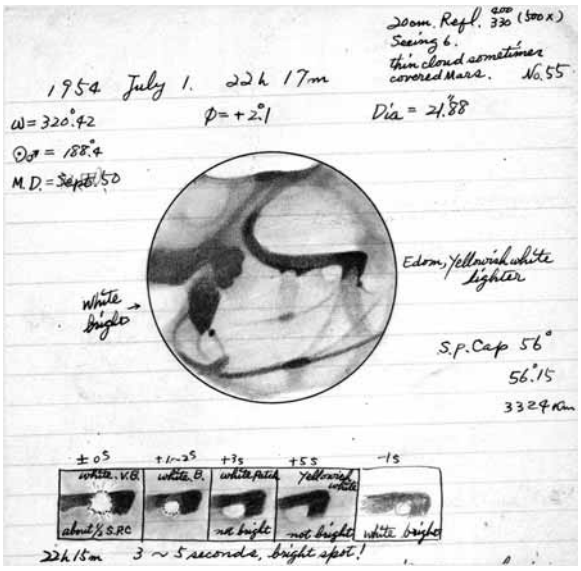
and Lou Ireland, Carolyn and Mark Peterson, Bob Itzenthaler, and Don Parker. Instruments were a 6-inch f/8 Newtonian for continuous visual observation from 05:51-08:36 UT and a 12-inch Meade SCT used in conjunction with a monochrome video camera, taping from 05:51-08:36 UT.

Observational conditions were very favorable, with light ESE wind and high cirrus. Seeing was 8 initially, deteriorating to 4-5 as the planet's altitude fell below 30 degrees. Clouds interfered with observations less than 20% of the time.

We will attempt to make further observations tomorrow morning (9 June UTD), but the areas of interest will not be favorably presented until Mars' altitude is less than 30 degrees.

A remarkable point of these observations was based on well designed plan of DOBBINS and SHEEHAN as above mentioned (see Ref. 1). Their prediction stemmed from their clever analysis of a few of precedent observations including Tsuneo SAHEKI in 1954, who detected a spontaneous brightening, more exactly on 1 July 1954 at 13:15 GMT. We shall cite here the original observation of SAHEKI:



As to what kind of these bright spot phenomena, there have been suggested several possibilities, for example a meteor's impact or a volcanic explosion or a solar reflection or a local disturbance of cloudy matter or something else. Let *De* be the sub-Earth point, and *Ds* the sub-Solar point. Then since in the case of SAHEKI the data implied *De*=2.1° N, *Ds*=3.4° S (according to the *Almanac*), that is, *De* is not so different from *Ds*, and (*De*+*Ds*)/2 gives (2.1−3.4)/2 =−0.6, that is, 0.6° S, so that the brightening point stays inside Edom Promontrium (namely the Schiaparelli crater which almost lies in the southern hemisphere). Furthermore, since *De*≈*Ds*, it was possible to consider that the phenomenon may suggest a reflection of the sunbeam. So they constructed the following Table for relevant *De* and *Ds* for the 2001 case as follows (p.123 in Ref. 1) based on the WIMP software:

Date	Time	*De*	*Ds*
4 June	5:15	1.0° N	3.4° N
5 June	5:58	1.2° N	3.2° N
6 June	6:28	1.5° N	2.8° N
7 June	7:04	1.7° N †	2.5° N
8 June	8:17	1.9° N ‡	2.3° N
9 June	8:53	2.1° N	2.1° N
10 June	9:29	2.2° N	1.8° N
11 June	10:06	2.4° N	1.6° N
12 June	10:42	2.6° N	1.4° N

(NB: WIMP gives slightly different values than the *Almanac*: For example, † should be 1.8° N and ‡ be 2.0° N.) They made thus a conjecture in Ref. 1 that if it was caused because of a solar reflection, a similar phenomenon might occur similarly in 2001: In order to verify the conjecture a troop for the observation was nicely organised including DOBBINS and PARKER in the US and they went to the Florida Keys where Edom faced to them on the days. We may say it was very courageous because the prediction made by the conjecture was anyway uncertain. Really on 5 and 6 July they failed to detect any flares at Edom, whereas very fortunately on the following 7 July they were able to check a series of bright spots at the anticipated target as is stated in the above-cited email from PARKER. Furthermore as was similarly cited they also succeeded to see another series of flares on the following night from 7:00 GMT to 8:24 GMT. Thus the prediction turned out to be right. In other words it became almost sure that the phenomena were caused by sun-glint reflections.

2 Discussion I

If the reflecting object on Mars lies horizontally just like a water surface in a deep well, the phenomenon will occur just when *De*=*Ds*. However it was not so in 1954; that is, *De* differed from *Ds* as was abovementioned. This time also *De* was not exactly equal to *Ds*:

In fact in 2001 on 7 June at 7h GMT, De=1.8°N while Ds=2.5°N (according to the *Almanac*). Furthermore (De+Ds)/2 was 2.2°N; That is, even if the reflecting matter is horizontally laid (the matter cannot be "water" because the atmospheric pressure is too low on Martian surface while the temperature is low), the location point is localised in the northern hemisphere and so we may say it was never Edom which lies on the southern hemisphere.

Hence we can conclude that the reflecting mirror is never laid horizontally, but it really a bit declines. Let Ψ be the declination angle, and then the brightening source is located at the following latitude:

$$\Phi = (De+Ds)/2 - \Psi .$$

If we assume the brightening source latitude Φ=1°S (the Schiaparelli crater is latitudinally located as large as from 1°N to 6°S). This implies $-1=2.2-\Psi$ so that the declination angle is Ψ=3.2°. It implies the angle is quite small but anyway it proves the reflecting matter is not located horizontally.

There exists however another problem even if we admit the declination, since the formula (De+Ds)/2 tells us that there are a lot of choices of combinations of De and Ds to give the same (De+Ds)/2 value and consequently we are led to the situation in which we cannot determine the date. However from the results in 1954 and 2001, we can at least say De is not so much different from Ds, and hence although the reflecting matter must have a bit declination, we can imagine that the place must have some depths from the surface so that the width of choices of De and Ds is narrow. In other words the reflecting objects stay inside such a narrow and somewhat deeper corridor like a trench, and because of the very reason, the condition that no more than De~Ds is allowed.

3 Discussion II

The proceeding discussion was made from the latitudinal view-point, but similarly we must discuss from the longitudinal view-point.

In the case of 7 June 2001 the central longitude was ω=335.8°W at 7:00 GMT. Since the width of Schiaparelli crater ranges from 339°W to 347°W, the central longitude does not fall inside Edom. Of course, there existed a phase angle ι, and really ι=6.0° on 7 June: Since it was before opposition the sunbeam came from westward. Now let Ω be the longitude of the brightening source. Then since $\Omega=\omega+\iota$, Ω=335.8+6.0≒342°W and then it becomes to lie inside Edom. However on this day the brightening began from 6:40 GMT when ω=330°W and so if the reflecting object is located horizontally the brightening source becomes outside the Schiaparelli crater. Furthermore on 8 June the phenomenon began to occur from 7:00 GMT when ω=327°W and so we may say it began from the outside of Edom if we assume the source is horizontal. On the day the phenomenon continued until 8:24 GMT when ω=347°W and so eventually the source lies inside Edom. However we should conclude that the brightening object must be declined also longitudinally i.e. declined in the E-W direction.

In the case of SAHEKI's observation in 1954 the phenomenon occurred at ω=320°W. On the other hand it occurred after opposition with ι=7° so that Ω=320−7°W. This implies the source is outside Edom if the object is horizontal. Therefore the reflecting matter should considerably be declined.

We may then conclude that even from the view-point of the difference of longitudes, the source in 1954 is different from the case in 2001. At least the angel of declination must have been quite different. Furthermore another difference exists since in the case of 2001 the flares occurred several times in a series; in this case there might have been several sources lined up in a trench in a wavy way which is elongated to be laid on an E-W axis.

4 Outlook

Even at the equatorial zone there is no "water" which may reflect the sunbeam, as was remarked in the above. In addition any result suggests that the reflecting matter is declined. Therefore the reflected flashes must be given rise to because the declined matter is made of frozen water or ice crystals or such mineral matter like a series of feldspar. The feldspar may be volcanic but in this case it can be considered to be made by the meteor impacts. (As to the possibility of feldspar, it was again pointed out by DOBBINS e.g. in Ref. 2.)

Next occasion will come in 2016 when the planet Mars will be at opposition on 22 May: It is hoped at around the time a similar observation of the spontaneous flares will be planned. As was suggested by Audouin DOLLFUS (see the Appendix), the polarimetric observations of the flares are well expected to be made.

Finally, we would like to thank Masami MURAKAMI for his kind help in calculating the data.

Appendix: We here cite for further reference in 2016 an email from DOBBINS in which he concretely stated in what way they observed the sun glints reflected from Edom at the Florida Keys in 2001:

Date: Tue, 08 July 2003 14:04:49 -0400
From: Thomas DOBBINS
Subject: A few suggestions concerning observing methods

Dear Masatsugu:・・・・・Based on my experiences in the Florida Keys in 2001, I offer the following advice...

Using a 30 cm Meade Schmidt-Cassegrain with a Barlow lens to provide a suitably large image scale, we found that the color video camera at our disposal (・・・・) gave markedly inferior images compared to a more sensitive monochrome camera used in conjunction with a Wratten #15 yellow filter. The yellow filter greatly reduced the effects of atmospheric dispersion and gave excellent contrast of the planet's albedo features.

The appearance of the Edom flares was first noticed on the television monitor, which as you can readily imagine is a very comfortable way to observe for a prolonged period of time, as it has far more eye relief than even the most sophisticated ocular!

This summer I will be employing a small short-wave radio receiver powered by a 9-volt battery that is tuned to the precise WWV time signal transmitted by the U.S. National Bureau of Standards at a frequency of 10 MHz. (・・・・.) Listening to the monotonous output on a speaker is surely a form of torture, so signal will simply be connected to the audio input connector of the VCR.

In Florida the smaller instruments (15cm Newtonians) used visually were aligned on an east-west axis and separated by distances of 10 to 20 meters. This allowed us to quickly determine that the pulsation and twinkling exhibited by the Edom flares were genuine and not spurious artifacts of turbulence in the Earth's atmosphere, as these events were seen simultaneously by the visual observers, who called out to one another "There goes another one - it's very bright now" in a fashion quite reminiscent of watching a meteor shower.

If any flares do appear, I hope that you will follow up on Audouin Dollfus' insightful suggestion to determine if their brightness changes when a polaroid filter is rotated. I'd keep such a filter installed in the ocular of one of the telescopes that will be used visually. ・・・・・

Kind regards, Tom DOBBINS

Ref. 1: T. DOBBINS and W. SHEEHAN, The Martian-Flares Mystery, *Sky and Telescope*, May 2001, pp.115-123

Ref. 2: T. DOBBINS, *private communication,* see CMO #375 (25 August 2010 issue) p. Ser3-0009.

2001年の火星観測報告.（その3）

－2001年6月のエドムの閃光現象－

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（要旨） 2001年6月7日、8日に米国で観測されたエドムの閃光現象を1954年の日本での観測と比較し、その発光体の傾きについて分析を試みた.

1954年7月1日，日本の佐伯恒夫氏が子午線の湾に隣接するエドムにおいて一時的な著しい輝きを観測した(図参照). これは日光の入射角Dsが中央緯度Deにほぼ一致することから起こった現象と考えられ，[具体的には(Ds+De)/2の方向に起こる]. 同じ様な現象が2001年の6月に矢張りエドム一帯に起こる可能性のあることをアメリカのトム・ドビンズ氏とビル・シーハン氏が予言した. そこで，ドビンズ氏とドン・パーカー氏を含む観測隊がエドムの見えるフロリダ・キーズに遠征し，見事6月7日と8日GMTにエドムに閃光を検出することに成功した. しかも，閃光は数回に及び，新しい課題を突きつけてきた.

この考察に於いては反射体による輝点が日光の反射によるものとしても，反射体が水平ではなく，いくらかの傾きを持つものでありその幾ばくかの計算を試みた. しかしDeとDsはそれほど大きな違いがないことから考えて反射体はいくらかの窪み，或いは塹壕と呼べるようなところに存在するものとわれわれは結論づけている.

また，反射体については氷の塊のようなものも排除できないがエドムに隕石が落下した際にできた長石(feldspar)であるという可能性もドビンズ氏などにより指摘されている. 塹壕は多分東西方向にかなり長いもので反射体は波状的に並んでいると考えられる.

今後同じような現象の観察できる時期のためにこれまでに採られた方法を参考のために採録してあり，今後の観測に必読である.

キーワード：火星，閃光現象，エドム

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