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Q & A about Pluto

Answered by

William SHEEHAN

AS we are now less than a month away from the **New Horizons Flyby of Pluto** (14 July 2015 - also the 50th anniversary of the Mariner 4 flyby of Mars) excitement is building, especially in Flagstaff, AZ, where Pluto was discovered 85 years ago.

William SHEEHAN, who with Robert GRABER (author of *“Plutonic Sonnets”*) will be recounting the history of the Planet X calculations, searches, and discovery at Lowell, the slow progress in understanding Pluto from the Earth-based observations, and the results from New Horizons in a special event at Lowell Observatory on 18 July, was recently interviewed by **Markus HOITAKANEN**, a Finnish science journalist and one of the participants in the 2009 Mars meeting at Paris and Meudon. Here is the gist of that interview:


Q Why was the decision made by the IAU in 2006 to re-classify Pluto as a dwarf planet? And why is it still controversial?


A: I will here cite the point of view of Dale CRUIKSHANK, who is an Investigator on the New Horizons mission (and co-authoring a book with me on Pluto):


“The decision by the IAU was forced by the dynamicists. Those of us who think of planets in terms of their physical characteristics rather than focus on the influence they have on their surroundings by gravity and


orbital sweeping generally favor the retention of the original planet classification. I would say that most of us are also comfortable with having more than nine full-fledged planets in the Solar System. Mike BROWN told me that his and other surveys had uncovered a few of these Kuiper Belt Objects like Eris (about the same size as Pluto) and slightly smaller ones but that there should be no more ‘big’ ones. Putting those into the hopper, and perhaps throwing in Vesta and Ceres, too, would give us a Solar System with about 18 planets. I would be fine with that.


"I make the point to those who inquire about my own preference on Pluto's classification that Pluto has more moons than the Earth, Venus, Mars and Mercury put together. It has an atmosphere and seasons. Its surface appears to change on long timescales through interaction with the atmosphere, as well as perhaps with the space environment, and so on. In short, it has a number of characteristics that would fit with a reasonable definition of 'planet.'"

 Finding Neptune was a triumph for theoretical astronomy and celestial mechanics. Why did they think there might lurk still another planet beyond Neptune?

 The discovery of Neptune was hailed as the "zenith of celestial mechanics." But there was no reason to think that Neptune marked the edge of the Solar System. For one thing, there were families of comets. Jupiter, Saturn, Uranus and even Neptune all had comets whose aphelia lay in the vicinity of those planets, which suggested they had been captured out there. A few comets also had aphelia farther out (and nowadays that does not seem at all surprising, since the Kuiper Belt and even farther out the Oort Cloud are there). FLAMMARION identified a "family" consisting of two comets and a meteor stream that was at around 47 AU. Was this the comet family of a trans-Neptunian planet? Then too there seemed to be small discrepancies between Uranus's observed and predicted paths. It was only a matter of a few seconds of arc, but for those who expected a planet might exist out there, it was enough to hang belief on.

 Finding "Planet X" seemed to have been almost an obsession for Percival LOWELL. Why was that?

 First, I think LOWELL was an obsessive type personality. He was prone to develop these all-consuming obsessions - the Far East, Mars, and in later years, Planet X. When his Mars and especially his Venus observations came in for criticism by professional astronomers, I think LOWELL took it very personally. Of course the public loved his speculations about intelligent life on Mars but he was treated dismissively by his peers. That was a main cause of the nervous breakdown which sidelined him from astronomy for several years. LOWELL thought of himself as a first-rate mathematician, and he does seem to have been quite good (he had been effusively praised by Benjamin PEIRCE when he had been PEIRCE's student at Harvard). So I think he took up the Planet X calculation because he wanted to emulate the grand triumph of John Couch ADAMS and Urbain LE VERRIER and bring all the astronomers who had criticized him to their knees with this tremendous discovery. Of course, it didn't work out for him. By 1915, he had done an enormous amount of work - one hardly grasps it from his privately published "*Memoir on a Trans-Neptunian Planet*," which appeared in September 1915. It had worn him out and probably helped drive him to an early grave. By the time he published his Memoir, he had pretty much given up. A friend of his said after his death, "It was the greatest disappointment of his life" not finding "X."

 What were the odds of finding Pluto so close to the predicted position?

A: Pluto was found six degrees from “a” predicted position. However, as Clyde TOMBAUGH realized when he started working on the photographic search in 1929, LOWELL’s positions kept shifting, because they are extremely sensitive to the values of the residuals, especially those based on the old pre-discovery observations of Uranus, and the different values of the mass, etc. W. H. PICKERING, who claimed also to have predicted the position of Pluto, also published numerous and sundry positions for a number of planets. With so many positions being published, the odds were high that a planet, if it existed, would be close to one of them or another. After the fact, the odds of Pluto being in that position were, of course, 100%, since that’s where it was.

Q: Would it have been possible to find Pluto without the aid of astrophotography?

A: No. Pluto could never have been found by visual researchers. There are simply too many stars of that magnitude, and even the best and most comprehensive star-maps compiled by visual observers — like the Bonner Durchmusterung for the Northern Hemisphere and the Cordoba Durchmusterung for the Southern, which were the products of decades of backbreaking work — go down only to magnitudes 9 or 10 or so. Pluto when discovered was magnitude 15.


Q: Was Clyde TOMBAUGH just lucky or was it hard work that enabled him to make the discovery?


A: Clyde TOMBAUGH was lucky in the sense that there was one Kuiper Belt Object bright enough to be within reach of his instrument. However, mainly the discovery of Pluto was the result of his utter dedication to the task he was assigned, meticulousness as an observer, stamina, and sheer hard work. He realized early on that the calculated positions of LOWELL were of no help to him. I would add that like a lot of great observers of that period, he came from a rural background. He grew up on a farm from Kansas. He was used to being self-reliant, was self-taught, good with his hands, and willing to work hard. His first home-made telescope, which he continued to use until his death when it went to the Smithsonian, made use of an axle from a 1910 Buick and a cream separator. Very few “city dudes” would have been able to pull that off.

Q: Finding out about the true nature of Pluto will obviously make it a less mysterious member of the Solar System. Will it also make it more fascinating?

A: We will undoubtedly understand much better the nature of the bodies in that region of deep-size, the chemical composition of those objects (water-ice certainly, as well as methane-ice, etc., some exotic organic chemistry) and the evolution of the outer Solar System, all of which is important. On the other hand, every time a mysterious object is brought into clear focus, it loses some of its romance. It no longer comprehends the whole range of possibilities it had before it was revealed. Though reality has a charm of its own, it isn’t as provocative to

the imagination. A case in point: Mars. I happen to remember vividly the dream of Lowell's canals that was still (slightly) viable before Mariner 4 arrived, and just how disappointing it was when the spacecraft flew past and returned all those stark images of lunar-like landscapes, craters and so forth. I was just a kid when that happened, and — coincidentally, or perhaps it was as meant to be — the New Horizons flyby will occur fifty years to the day after the Mariner 4 flyby. Apt bookends of Solar System exploration! Still, we have no choice — we have to explore, come what may. I can't help paraphrasing what Œdipus says in Sophocles' great play, "We must learn our lineage, be it e'er so low."

 How do you feel about the fact that New Horizons went to study a planet but it will make a fly-by of a dwarf planet?

 : It reminds me of a movie from some years ago, "*The Englishman Who Went up a Hill But Came Down a Mountain.*" (a 1995 British film, written and directed by Christopher MONGER, and played by Hugh GRANT etc.)

When New Horizons was launched in January 2006 - and I was at Cape Kennedy and saw it off; 2015 seemed like a very long time in the future then, and now it's here! - it was still officially classed as a planet; now it's officially a dwarf planet and a Kuiper Belt Object. The climbing up a mountain and coming down a hill would be a better analogy than the one I stated above. It's a testimony, however, of how fast the ground is shifting beneath our feet. The exploration of the Solar System has been going at high speed and we know so much more than we did less than a decade ago. The problem is how to possibly keep up with everything. □

Winter Hellas in 2014

By

Christophe PELLIER

ISMO 2013 | 14 Mars Note (#08)

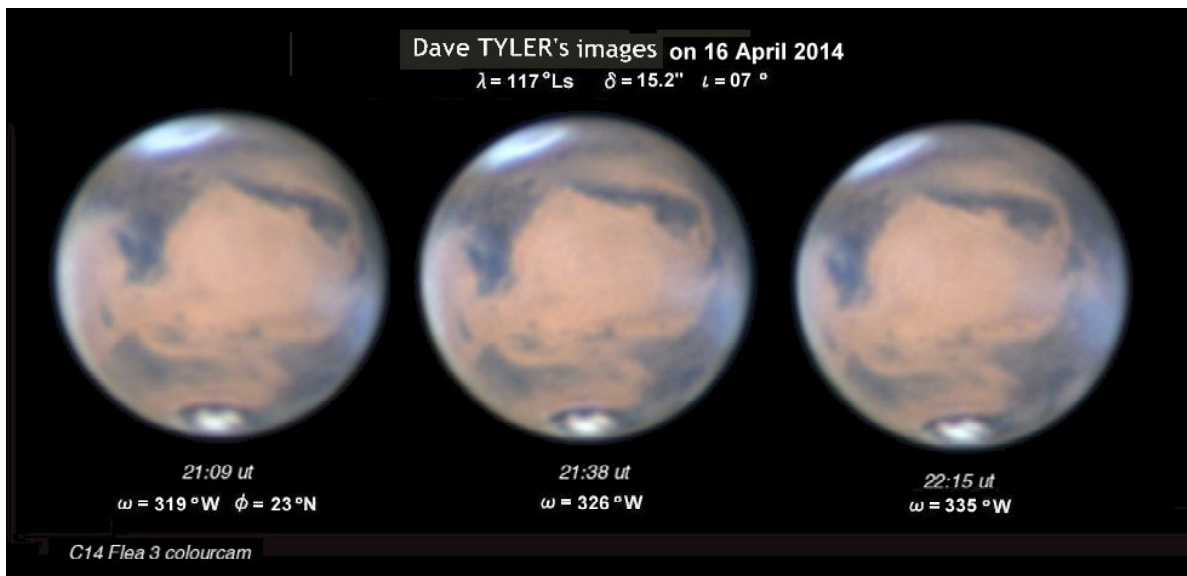
FOR the 2012 apparition of Mars we proposed a detailed description of the winter state of the Hellas basin (in [CMO #410](#), and refer as well to [CMO #409](#) for the "escaping cloud"). In 2014, the advanced Martian season ($\lambda=114^\circ\text{Ls}$, early northern mid-summer, against $\lambda=076^\circ\text{Ls}$, late spring in 2012) allowed us to observe the full winter state, with all the previous observed features, and marginal novelties.

Completion of the winter state

The Hellas winter state is reached when the atmospheric carbon dioxide condensates into

frost on the ground of the basin. From the Earth, we see Hellas as whitish bright, as much as a polar cap - and it is a true extension of the winter south cap that remains invisible in permanent night. The state is reached on or shortly after the winter southern solstice ($\lambda=090^\circ\text{Ls}$). In 2014, the season visited on 15th February, and there is very little amateur data available around this date. The looking at MARCI movies produces ambiguous results, Hellas being displayed very closed to the southern limb at an unfavourable angle of view. Hellas is becoming bright at least around the solstice (Brian COMBS on 17th February 2014

Fig. 1: The bright winter Hellas setting away from view. Images by Dave TYLER



and Don PARKER on the 18th February 2014 ($\lambda=090|091^\circ\text{Ls}$), so the chronology looks identical to that of 2012.

Still, two points were pending in 2012 :

- The visibility on amateur images of the Terby crater (285°W , 27°S),
- The exact nature of the shades observed inside Hellas. Simple holes into the clouds or true ground areas free from frost ?

The Terby crater as the northern limit of cap extension

The Terby crater is a relatively small crater located at the north-east of Hellas, outside the mountain ring of the basin. It gets frosted during winter so we may consider it as the lowest (northern) extent point of the Hellas dry ice, and then of the south cap itself. In 2012, this little crater was not seen on amateur images. See Figure 2 for a general topographic map of Hellas.

Terby is 171 km wide. This means that in 2014, when the planet reached the maximum diameter of 15.2 arcsecond, its angular width was 0.39", meaning that it was in theory at the limit of detection of a 300 mm telescope (providing its contrast was high enough thanks to shining

frost).

Only one amateur image looks to show it without any ambiguity, taken by Chris GO on 5th April ($\lambda=112^\circ\text{Ls}$) with a 35cm telescope and when the apparent diameter was 14.9". Some other high-res images show the area as a whitish

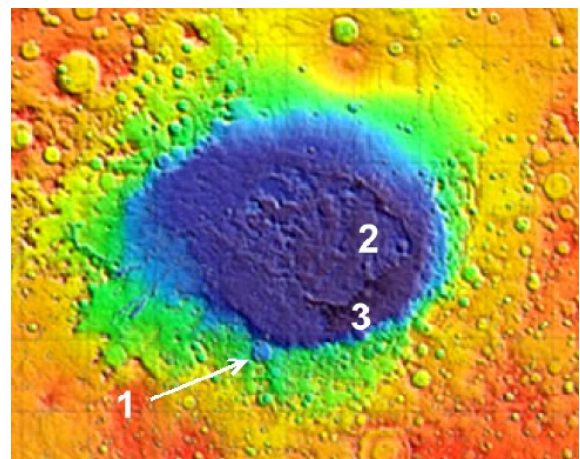


Fig. 2: Relief map of Hellas, taken from the general MOLA map (Mars Global Surveyor). Mean altitude (zero level) is yellow; red figures out an altitude of 4 km above mean level, deep violet is down to 8 km beneath mean level. **1: Terby crater. 2: Alpheus Colles, the inner plateau, slightly prominent. 3: deepest part of the Hellas basin, and therefore of the whole planet. South is up.**

"pointed" end of the Hellas basin, but not as a little white circle, even if the resolution reached elsewhere on the disk is equal to that of Chris GO's image. This is the case for example of all excellent images taken by Damian PEACH at Barbados in late April 2014 ($\lambda=120^\circ\text{Ls}+$). It's hard to explain why the crater remains not clearly resolved in such cases, but it could be because of

clouds passing over the region or, on some particular images, an insufficiently resolved blue light image (this being probably not the case for the Barbados data). See Fig. 3 for the original images. (*Editorial Note**: Reiichi KONNAI is of the opinion that Anthony WESLEY's image on 4th April might be added. Refer to the Remark put at the end of this article.)

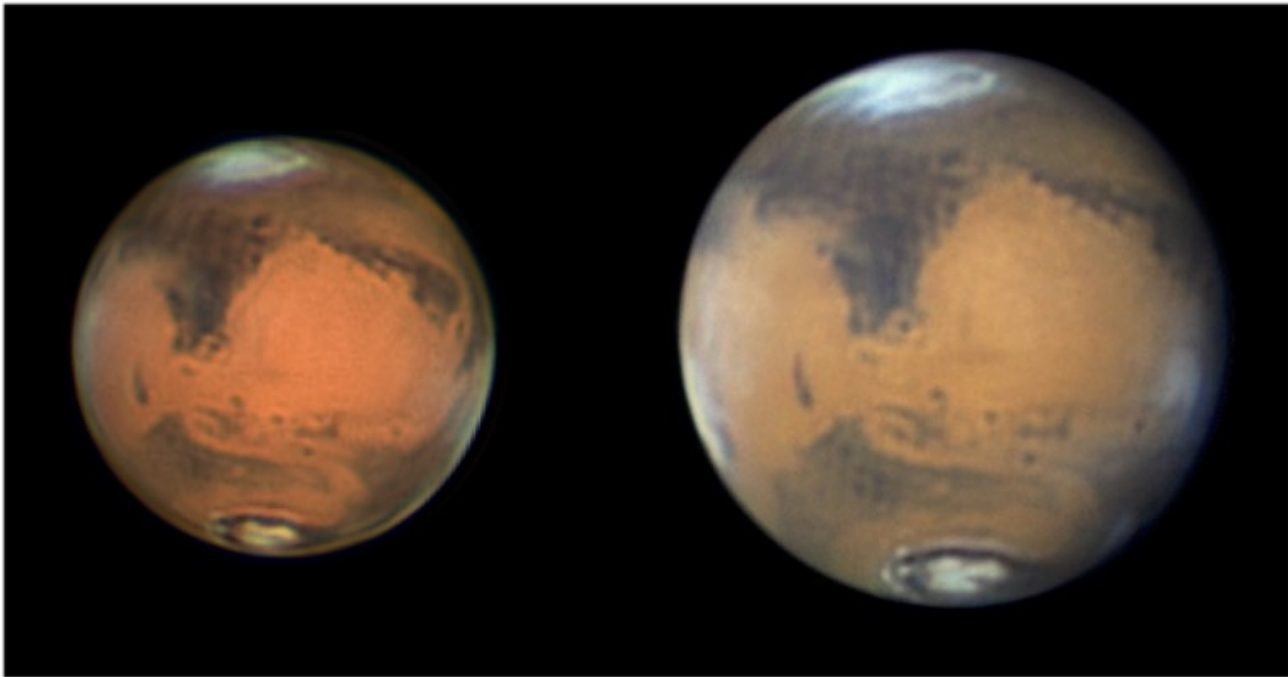


Fig. 3: left image by Chris GO on 5th April 2014, and right by Damian PEACH on 27th April

It would be very interesting to establish the exact moment when this crater is frosted for each Martian year since we could say this is the last step of winter setting in the south.

Dark shades inside Hellas

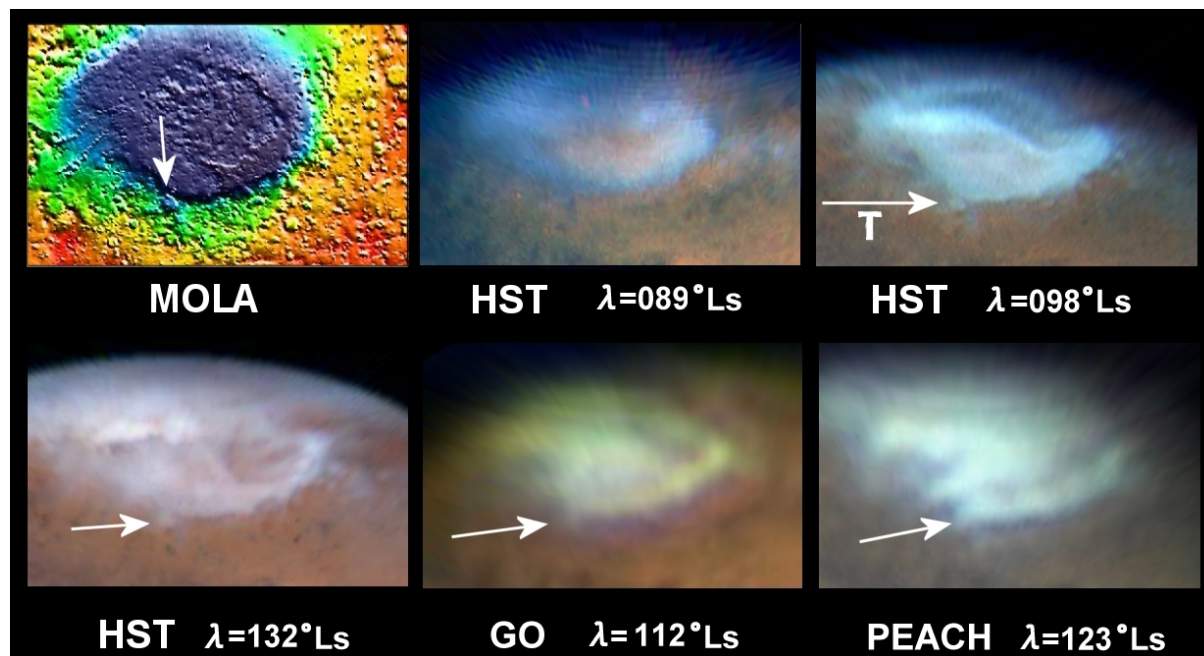
Sometimes Hellas can look fully white but most of the times, some shading is distinctly seen. Winter inside Hellas begins with a gathering of white clouds in late fall and so it can be hard to decide when exactly the frost condensates under the clouds since both have the same colour (albedo may differ though, please refer to CMO #410). As a result it can not be clear to know if the dark shades are simply holes in the clouds or ground areas free from frost. The comparison of some HST images taken in 1997 and 1999 with some 2014 Mars images, and good maps of the planet, can help us to clarify more precisely how

does the frost behave inside Hellas. Refer to Fig. 4 at the next page.

There is at least one area that looks dark most of the time, so it must be free from frost. This is a curved band of terrain on the north-west quadrangle of Hellas, south of the north mountain ring but north of a slightly higher plateau roughly located at the centre and that is called *Alpheus Colles*. This curved band is dark on the HST 1999 image, as well on GO's and PEACH's 2014 shots. It looks rather white in the 30th March 1997 HST shot but on the 10th March 1997 previous image it's interestingly free from gathering clouds (the 2010 amateur data show this as well clearly).

Opposite to this band, on the south-east quadrangle of Hellas, is a region that displays one of the brightest area of the winter Hellas

Fig. 4: Comparison maps of Hellas. HST at $\lambda=089^\circ\text{Ls}$: taken just before winter solstice on 10th March 1997: the frost is clearly not present, only clouds are detected. HST at $\lambda=098^\circ\text{Ls}$: same year but on 30th March: at early winter, the Terby crater is now frosted. HST at $\lambda=132^\circ\text{Ls}$: mid-winter state on 1st May 1999. The last two images are that of GO and PEACH from Fig. 3. The Terby crater is arrowed. South is up.



(HST 1999, amateur data 2014 for example). There is no particular name for this area but it looks to be the most direct and non ambiguous edge of the winter south cap.

So we may describe the winter state of the Hellas basin as being cut into three regions displaying different conditions:

- 1) the south-east quadrangle is the coldest part, is always frosted and must be directly connected to the south cap itself
- 2) the northern mountain ring: being a pole-facing slope, it receives less solar insolation than equivalent areas elsewhere at the same latitude. It is then an area that favourably welcomes the formation of clouds and CO₂ frost during winter. This explains the whitish "ring" that sometimes draws the north border of Hellas.
- 3) The curved band between the two presents, for opposite reasons (a Sun-facing slope due to the presence of the Alpheus Colles pla-

teau, or at least a regular horizontal plain to some extent) less favourable conditions for winter clouds and frost, despite being the lowest point of the whole planet (- 8 km under mean level).

In 2016, we will have a very good opportunity to study the next seasonal stage of Hellas: the decay of winter conditions and the dissipation of clouds and frost with the approach of spring equinox. The season is included in the 2014 apparition but the angle of view from the Earth was unfavourable to this study (the south pole being largely tilted away from view). □

**Editorial Remark:* Please also refer to his LtE dated 6 April in [CMO#422](#) at p.Ser3-0705 (25 May 2014) where Reichi KONNAÏ (*Kn*) remarked that [Anthony WESLEY](#) (*AWs*) already showed the frosty Terby crater at the northern limb of Hellas on 4th April. *Kn* still believes *AWs*'s modest image is the best; the finest details being rather rich in diversity.

Letters to the Editor

●...*Subject: Re: from bill sheehan: news*
Received: 31 May 2015 at 04:44 JST

Dear Masatsugu, It is always a pleasure to hear from you, though I read with concern about the continuing heart troubles. Thank you for reminding me of your article about Flamsteed vs. Newton, which I will now read again.

Lately I have become very interested in the careers of the hardworking observers in positional astronomy like Flamsteed, Bradley, and Airy (and let us not forget Bessel who was perhaps the most gifted of any of them). My recent visit to Greenwich has enhanced this interest. Obviously it was their ability to obtain measures of planetary positions accurate to a few seconds of arc that betrayed the discrepancy between the theoretical and observed positions of Uranus that led to the discovery of Neptune. So perhaps I may continue the X-tracts from the X-file now to show how that story turns out. Perhaps, however, I should write a brief essay about the coincidence in dates between Mariner 4's flyby of Mars of July 14, 1965 and the New Horizon's flyby of Pluto of July 14, 2015, with some reflections on just what an era we have lived in. This may put readers in the mood of the Great Event we are expecting soon. Perhaps I should say a few words about Clyde Tombaugh's role as a Mars observer? something he wanted to be remembered for. I think his interest in Mars was greater than just about anything else.

I will come up with something for you - never fear.

I plan to be in Flagstaff July 9-23 -what better place to be to enjoy the flyby of the little world that was discovered there on Mars Hill? I have decided that this would be far more pleasant than being crowded by the press people at Laurel, Maryland,

where the scientists will gather. I have made arrangements to be in touch by phone with Dale Cruikshank, who will be there, who can give some firsthand impressions of what we are learning from our spacecraft on the icy fringe of the Solar System.

All the best, Bill

 On May 30, 2015, at 2:25 PM, Masatsugu MINAMI wrote:

Dear Bill, Thank you very much for your timely news. It's good to hear from you after a while. It was interesting to read about the nice trip to the northern England of you and your wife. We received the email on the very morning of 25 May JST when we were editing CMO #434, and hence we put it readily in the LtE corner of #434.

<http://www.kwasan.kyoto-u.ac.jp/~cmo/cmomn4/CMO434.pdf>

I remember some names of towns are familiar to me. . . .
 . . . I also remember the old Greenwich together with the tea clipper ship Cutty Sark. Inside the old Greenwich Observatory, the statue of Flamsteed was very impressive to me. Have you ever happened to read my following old essay entitled "Great Comet in 1680 and Flamsteed vs Newton"?

<http://www.kwasan.kyoto-u.ac.jp/~cmo/cmomn2/Cahier07.htm>
 in which I wrote "The statue of Flamsteed at the old Greenwich Observatory is filled with the atmosphere of anguish, but it is not only because of his illness but with the result of the battle with the 'fearful, cautious and suspicious' Newton."

Now I would like to ask you to write some opening essay for CMO #435 (June issue) as you suggested. The dead line is around 15 June.

Thank you again for your kind correspondence, and I look forward to your opening essay for #435 on any subject.

With best wishes, Masatsugu

PS: I am going to receive a re-examination (cardiac catheterisation) in hospital on 5 June because I feel angina attacks very often recently. I have already a pair of stents in my coronary artery.

 ○...*Subject: For ISMO*
Received: 14 June 2015 at 06:10 JST

Dear Masatsugu, We are getting very excited now about the New Horizons flyby, so I thought I would send a brief Q and A I did for Markus Hoitakanen (do

you remember him? He was at the Paris and Meudon events of 2009).

Hope all is well with you.

All the very best,

yours,


○...*Subject: Re: For ISMO*

Received: 18 June 2015 at 07:42 JST

Dear Masatsugu, I am very pleased that your health has remained stable.

I do well remember Takashi Nakajima - he was a great companion, very learned about literature as well as Mars - especially I remember the three of us visiting the Fukui City Observatory together, scene of all your observing exploits. Unfortunately, Mars was not well placed, so we were unable to view it; however, we did have a good look at Jupiter. . . . We did have a nice drive together and talked a good deal, but I recall that he smoked almost constantly.

I will think of a continuation of one of the other articles - probably the one on Planet X. At present I am working to prepare a multi-media event to be given at Lowell Observatory on July 18 recounting the history of Percival Lowell's search for Planet X, the discovery by Clyde, some phases of the ground-based investigation of Pluto and some comments on the images from New Horizons spacecraft which will just be received that week, so this has me busy.

I think you may find of interest a paper just published by *the British Society for the History of Astronomy*, in their journal *The Antique Astronomer*. → 

This is a text (with illustrations) of the talk I was invited to give (and gave successfully) at the National Maritime Museum in Greenwich in March. You are mentioned in the credits, and you will also find of interest some of the lovely drawings that Laurie Hatch did at Mt. Hamilton. in 2005.

Kind regards,

Bill SHEEHAN (Willmar, MN, the US)

●...*Subject: Re: How are you going?*

Received: 16 June 2015 at 05:33 JST

Dear Masatsugu, I will try to send you my Note tomorrow. Research work took a bit more time than expected - at final it will be a note about the winter Hellas in 2014...

Best wishes,

○...*Subject: 2014 Note #08*

Received: 17 June 2015 at 05:32 JST

Hi friends, Here is my Note for CMO#435. Please tell me if you have some remarks...

Best wishes,

Christophe PELLIER (Nanthe, FRANCE)



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