

VOL. 12, NO. 1

JANUARY 31, 1979

# DAVID DUNLAP DOINGS



Cover: p.3

Photo - Karl Kamper

$\epsilon$  Per

$\epsilon$  Per is a bright ( $B=2.7$ ) star which has been known as an SB2 for several decades. No orbit has ever been determined. It was placed on the bright spectroscopic binary program on the 74-inch in 1970. Since that time, we have obtained more than 100 spectrograms at dispersions of 8 and 12  $\text{\AA mm}^{-1}$ . For the past couple of years Jim Thomson has been measuring these and trying to make some sense out of the system. Until recently he has had little luck in determining the period. The problem was complicated by the near equality of the components and the fact that at times there appeared to be not two but three components present in the spectrum.

After numerous attempts to find the binary period, Jim has accidentally discovered that one of the components is a  $\beta$  Cep star with a period of 3.8 hours. This is not surprising by itself, since  $\epsilon$  Per has appeared on a number of lists of suspected  $\beta$  Cep stars. The surprise is that the velocity amplitude is approximately 200  $\text{km s}^{-1}$ ! This surpasses the previous champion, BW Vul, by a substantial factor. Visual inspection of the plates shows that the star undergoes line profile variations very similar to those seen in BW Vul. This accounts for the occasional appearance of triple lines in the spectrum.

Jim is still looking for the binary period. There are indications that it may be long, or at least that the amplitude of the binary velocity variations is small.

Tom Bolton

#### KING ON CLOCKS

*On November 27 the University of Toronto Press held a cocktail party at the McLaughlin Planetarium to celebrate the publication of Henry King's magnificent new book 'Geared to the Stars'. Among those attending were Helen Hogg, Ernie Seaquist, and Don Fernie, as well as many astronomical friends from the Toronto area.*

*The volume, subtitled The Evolution of Planetariums, Orreries and Astronomical Clocks, done in collaboration with John R. Millburn, must surely rate as the definitive work on the subject. Those attending the party were treated to some of the impressive statistics the book encompasses: the foot-high, thousand-page manuscript, the one thousand four hundred and ninety footnotes, the hundreds of beautiful illustrations, all collected within the 442 8 x 11 superbly printed pages.*

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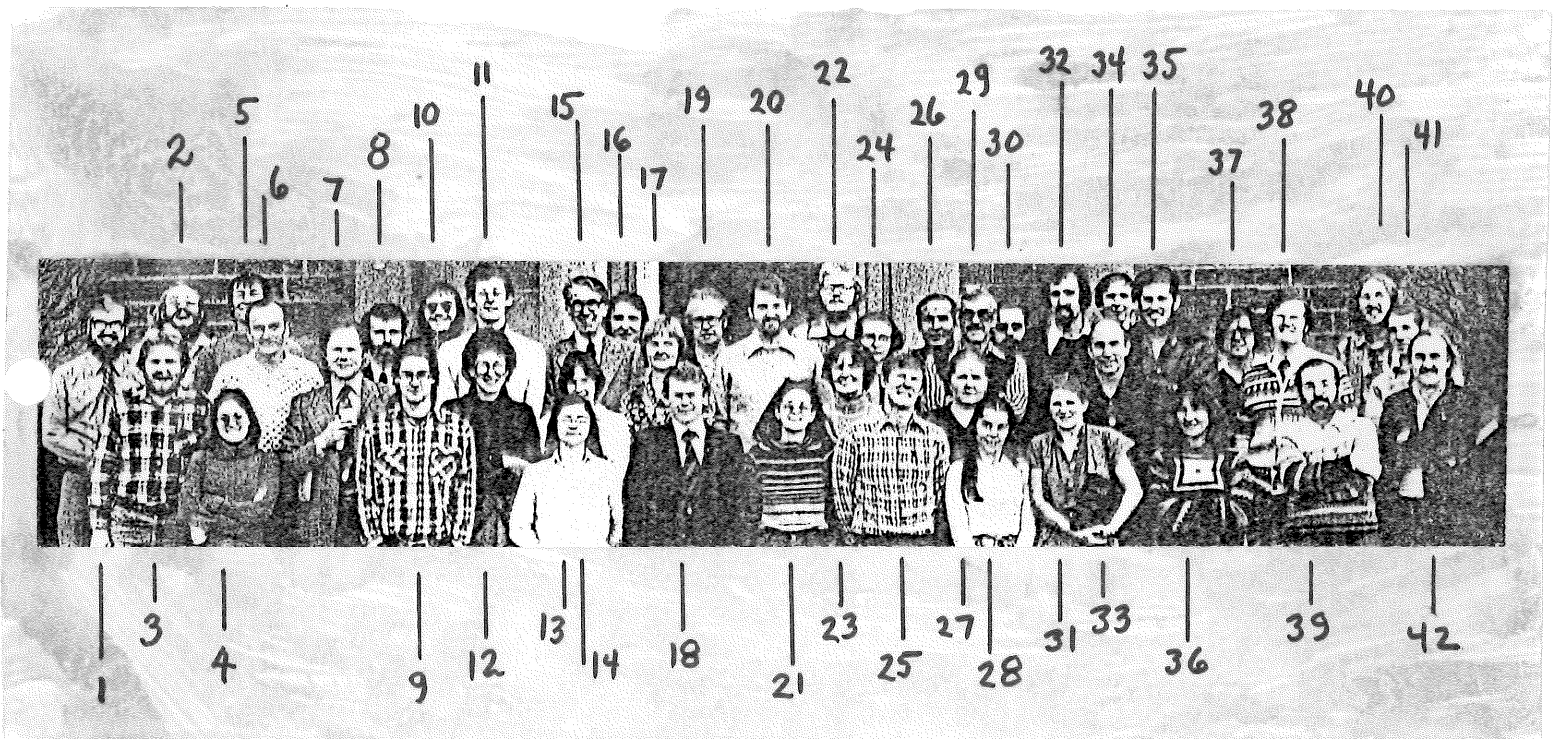
Helen Hogg has already donated to the DDO library a copy of the book in memory of R.K. Young, and the Planetarium, in recognition of the ten years of cooperation between our two institutions, has donated a second copy to the Department.

So to Henry our congratulations, to Mary King, who typed all three hundred thousand words, our sympathy, and to our donors our grateful thanks.

Henry's parting words to me at the party were "Don, I read your book cover-to-cover; I expect no less from you!" Henry, I can but try.....

JDF

AT THE CHRISTMAS COUNTDOWN 1978



- |                    |                       |                         |
|--------------------|-----------------------|-------------------------|
| 1. Dave Turner     | 15. Don MacRae        | 29. Don Fernie          |
| 2. Jim Thomson     | 16. Jim de Roux       | 30. Charles Dyer        |
| 3. Gerry Grieve    | 17. Joan Tryggve      | 31. Gail Archer         |
| 4. Donna Zubrod    | 18. Bob McLaren       | 32. Barry Madore        |
| 5. Archie Ridder   | 19. Ernie Seaquist    | 33. John Lester         |
| 6. Dave Earlam     | 20. Tom Bolton        | 34. Jim Clarke          |
| 7. Maurice Clement | 21. Dot Fraquelli     | 35. Al Irwin            |
| 8. Frank Hawker    | 22. Chris McAlary     | 36. Dominique Barceloux |
| 9. Chris Rogers    | 23. Christine Clement | 37. Larry Morrill       |
| 10. Stuart Button  | 24. Lindsey Davis     | 38. John Percy          |
| 11. John Reid      | 25. Rick McGonegal    | 39. Jose Maza           |
| 12. Zane Sterns    | 26. Tony Estevens     | 40. Doug Gies           |
| 13. Joan Wrobel    | 27. Mary Lane         | 41. Chris Corbally      |
| 14. Esther Oostdyk | 28. Pamela Sullivan   | 42. Matt Bates          |

ASTRO CRYPTIC

That scurrilous parody, the Droppings for 1978, carried a clever cryptic, the solution to which we design to publish. For those who did not see the Droppings, never mind - you're better off! But here are a few of the clues, which way and where being is up to you to puzzle out.

*For a long way these 12 months are not heavy. (5,4), Fifty in cement. (7), Son of a sunbeam? (6), A stellar soap opera when Jim Thomson wakes up. (2,3,4,5), Unrefined metal follows crazy prof. (6), The last of Joan gives more than a bad paradox.(5), This is high in smoggy Europa city. (7).*

C.T. (for Thomas) CLAUS

We don't aspire to be a newspaper of record but for fear this item might get lost in the swirling snow of the Christmas season, we print part of the finale of the Xmas Countdown. Actually the carol has come down through the ages with occasional modifications. Authors shall remain anonymous. The music is obvious, and joyful.

1. YOU'D BETTER WATCH OUT  
AND TRAIL YOUR STAR WELL  
CAUSE IF YOU SCREW UP  
YOU'RE GONNA CATCH HELL  
C.T. CLAUSE IS COMING TO TOWN

3. SO KEEP ON YOUR TOES  
AND WORK WELL WITH JIM  
CAUSE IF YOU SCREW UP  
YOUR FUTURE IS DIM  
C.T. CLAU IS COMING TO TOWN

*Refrain:*

*HE KNOWS IF ITS BEEN CLOUDY  
HE KNOWS IF YOU'RE AWAKE  
HE KNOWS THE CALIBRATION'S GOOD  
SO EXPOSE FOR GOODNESS SAKE*

4. YOU'VE GOT TO DO RIGHT  
AND STAY HERE TILL FOUR  
CAUSE IF IT CLEARS TONIGHT  
HE'LL BE AT YOUR DOOR  
C.T. CLAU IS COMING TO TOWN

2. HE'S MAKING THE SCHED'  
AND CHECKING IT TWICE  
YOU'LL ONLY GET TIME  
IF YOU'RE REALLY NICE  
C.T. CLAUSE IS COMING TO TOWN

5. YOU'D BETTER NOT SHOUT  
YOU'D BETTER NOT MOAN  
CAUSE IF HE FINDS OUT  
YOU'LL BE OBSERVING ALONE  
C.T. CLAU IS COMING TO TOWN

## THE BIG EYE

In spite of the warm weather in November and December we are experiencing our second winter in a row of good observing weather. Normally we have about 160 hours of observing time in the period November-January. This year we have logged more than 220 hours during this period with two weeks still to come.

The cold weather observing has not been without its adventures and misadventures. The major problem has been the TV guiding system. The camera tube has been in use well beyond its rated lifetime, and it was showing signs of incipient failure throughout the Fall. We had ordered a new tube from RCA last Spring, but there was no sign of it being delivered - unless you count the various requests for payment from RCA. It finally showed up just before Christmas, and everyone breathed a sigh of relief. Then the power supply in the camera blew just as the shop was closing down for the Holidays! RCA has promised to deliver a new power supply by the end of January. Meanwhile we have returned to guiding techniques used in the ice ages past.

The cold weather has also given us some problems with the deckers on the image slicers. The one on the red slicer becomes almost immovable at temperatures below  $-10^{\circ}\text{C}$ . This is not surprising since these devices have never been used at an observatory that operates at as low temperatures as we experience in the Winter. Fortunately, the problem is relatively easy to correct.

The dome shutter closing mechanism required repairs on January 12 when the pins holding the drive gear on the shaft sheared off. It is not clear when or how this happened. It may have been normal wear and tear, but it is more likely that someone opened the shutters too far or closed them too tight.

Archie Ridder has completed the new plateholder assembly mentioned in this column in the November issue and modified two of the plateholders to fit. Tests show that the spectrograph focus is much more stable with the new system than with the old.

Tests have continued with the image slicers in an effort to identify the source of the aberrations. So far we have discovered that the comparison is not illuminating the grating uniformly, but the cause of this has not been determined. I will be taking the blue slicer to DAO at the end of January for consultation with Harvey Richardson and Murray Fletcher. The blue slicer may be unavailable for some time.

Matt Bates and I have completed the necessary measurements for calibrating 15 of the 19 spots in the spot sensitometer. These were done after a series of careful tests by Frank Hawker and me to insure that the photometer was working properly. Unfortunately, the remaining measurements are being delayed while we try to identify and correct the cause of the large monotonic upward drift in the phototube dark current that developed before the measures could be completed.

Tom Bolton

## CFHT NEWS: THE HAWAII EYE

The December meeting of the Board of Directors was held this year on the Big Island where the headquarters of the CFHT Corporation are located and where current activities are concentrated. We visited the top of Mauna Kea and saw the telescope

taking shape inside the dome. The last of the many pieces had just arrived at the summit.

The December meeting, as usual, was largely concerned with financial affairs. This time the Directors tried to plan the budget for the Operation Phase, as distinct from the Construction Phase which will soon be terminated (at a total cost of between 29 and 30 million current dollars). We fear it will cost more to operate this magnificent observatory than the 1.6 million current dollars planned at that time. In part this is a reflection of a greatly increased sophistication of our science over even that short time interval. It also reflects a realization, now that the project is nearly complete, that we have one of the most powerful optical telescopes in the world at our disposal.

I ended my term as Chairman of the Board on December 31, but remain a member for another year. Two new Canadian members came on the Board on January 1, Rene J.A. Levesque who is Vice-President (Research) of the Universite de Montreal, and Dr. Howard Petch, President of the University of Victoria and long a friend of astronomy. Going off the Board in turn were Larkin Kerwin of Laval and William Armstrong, formerly Dean of Engineering at U.B.C. Prof. Ch. Fehrenbach is the new Chairman.

MR

#### THESIS ABSTRACT

*Shyam Jakate completed his Ph.D. requirements this month. The abstract of his thesis appears below.*

#### "A SEARCH FOR NEW $\beta$ CEPHEI STARS"

Shyam Jakate

The results of a photometric search for  $\beta$  Cephei stars conducted among a group of 37 southern B type field stars and in an open cluster NGC 4755 are presented.

Two new  $\beta$  Cephei stars, HR 3924 and HR 3941, were discovered in the field. They have the shortest periods, coolest temperatures and lowest luminosities, compared to the so far known  $\beta$  Cephei stars. Their position in the instability strip suggests the extension of its low luminosity end to at least  $M_V = -2.55$  mag.

Sixty constant stars and twelve suspected  $\beta$  Cephei stars from this and three other similar surveys are plotted on the [u-b],  $\beta$  plane along with the twenty-one confirmed  $\beta$  Cephei stars (Shaw 1975). All the constant stars seem to lie outside the instability strip.

A log Te-amplitude diagram is presented for the confirmed  $\beta$  Cephei stars. This diagram seems to suggest that a high rotation in a  $\beta$  Cephei star reduces its amplitude of light variation.

A search in NGC 4755 has resulted in three new  $\beta$  Cephei stars (F, I-05 and IV-18). It is demonstrated that the open clusters can be used to determine the evolutionary status of the  $\beta$  Cephei stars. A comparison of the position of the "gap" in the post-main sequence evolution of the clusters NGC 4755 and 3293, with the positions of the  $\beta$  Cephei stars identified in them suggests that the  $\beta$  Cephei stars are in the core hydrogen-burning phase of evolution.

This survey has also resulted in the discovery of four new early-type ultra-short-period variables (EUSP) with periods less than one hour. These are mainly of B2 V and B3 IV spectral types and they lie very close to the zero-age main sequence. Their properties as a group and their observational similarities to the  $\beta$  Cephei stars and to Eggen's (1971) zero-age ultra-short-period  $\delta$  Scuti stars are discussed.

The survey has also identified several other kinds of variables. The "short-term" variation observed in three Be stars is discussed in the light of their "long-term" light variations reported in the literature. An attempt is made to demonstrate that these "long-term" light variations could well be the "short-term" light variations of the type reported here.

A list of "slow" variables with periods longer than 7<sup>h</sup> from this and three other surveys is given. The importance of "slow" variables is stressed in regard to the possibility of them being non-radial pulsators of Smith's (1977) kind and therefore related to the  $\beta$  Cephei stars.

A new He-weak variable and a new eclipsing binary system were also discovered as a result of this survey.

REV. MICHAEL WALTER BURKE-GAFFNEY

*Father Burke-Gaffney, a strong supporter of astronomy in the Maritimes and an astronomer in his own right, died in Halifax on January 14, 1979.*

*Dr. Burke-Gaffney's soft Irish accent revealed the land of his birth. He received his doctorate from Georgetown University and for a time taught astronomy at Regis College in Toronto. In 1940 he went to Halifax as one of a group of Jesuit priests sent to establish St. Mary's University there. He was professor, and also for a time dean, of engineering until 1955, when he started the astronomy group at St. Mary's and became professor of astronomy, a post he held until his retirement in 1965.*

*Those who knew Father Burke-Gaffney well will remember his infectious enthusiasm for astronomy and his very gracious and friendly personality. More widely he will be remembered by Canadian astronomers as the founder of the flourishing observatory in Halifax which now bears his name.*

TRAVELS WITH BARRY

Travel all the way to Israel just to be clouded out? To some extent that is almost what happened to me in November. My one-day tour of Jerusalem was completely overcast with the occasional hint of rain.



Fortunately this came two days after a nearly perfect run using the RGO electronographic camera attached to the one-meter reflector owned by the Wise Observatory of the University of Tel Aviv. For obvious reasons the telescope is sited south of Tel Aviv on the edge of the Negev desert and not in Jerusalem.

My flight back was not uneventful although none of the action (inaction?) took place anywhere near the Middle East. Industrial disputes at Heathrow, ice on the runway at Montreal and fog at Toronto turned a pleasant seven-hour trans-Atlantic flight into a 42-hour ordeal.

BFM

### S T A F F I N G

*The Department and Observatory have now received Sidney van den Bergh's official resignation, effective July 1, 1979. This, of course, came as no surprise, but was nevertheless received with regret. Our thanks again to Sidney for his twenty years of service to the University of Toronto, and our best wishes for a fruitful and happy career at the DAO.*

*Barry Madore will continue as Sidney's replacement at least until July, 1981. A decision as to whether the position will then become a tenure-stream one is expected to be made by the University next fall.*

*Approval has been received for Bill Clarke to continue his leave of absence for one more year up to July 1980. He will continue to be replaced during this period by Dave Turner.*

JDF

### POTPOURRI

*Shyam Jakate was married on December 16, and he and his bride, Shuba spent a two-week honeymoon in India. On January 19 Shyam successfully defended his thesis "A Search for New  $\beta$  Cephei Stars" (abstract on p. 6) and two days later he left for Belgium to take up a postdoctoral position at the Astrofysisch Instituut, Vrije Universiteit Brussels. Dr. J.S. Shaw, University of Georgia, was Shyam's external examiner and spent a day in the department.*

*Helen Hogg has received a special award for her contribution toward international recognition of the town of Richmond Hill. The award, a silver brooch bearing the town crest, was presented at the Richmond Hill Annual Awards Banquet on November 24.*

*Frances and Mathew Bates are the proud parents of an 8 lb 3 oz (3.71 Kgm) boy, David Matthew, born January 20 at St. Joseph's Hospital. A similar happy event occurred for Ruta and Colin Asimus on January 6 with the arrival of 8 lb 1 oz (3.66 Kgm) Kristine Erika. Ruta was DDO librarian from July 1974 until September 1976.*



*Phil Kronberg* and *Martinine Simard-Normandin* had a very successful observing run in December measuring QSO and radiogalaxy polarizations at 2 cm with the 100-m Bonn telescope.

*Dennis Crabtree* and *Bob McLaren* had a 6-night run in January on the 1.5 m telescope at CTIO doing infrared photometry of carbon stars in the LMC. Enroute to Chile, Bob and Dennis spent four days in Rio de Janeiro sightseeing and getting sunburned at Copacobana.

*Phil Kronberg* and *Peter Biermann* spent a week in January at NRAO, Charlottesville reducing VLA data.

Congratulations to *Chris Rogers* who passed his Oral General Examination on November 29.

#### TALKS GIVEN

*John Percy* has been as active as usual on the public lecture circuit during the past two months. On December 12 he gave a talk on "Astronomy: Man's Greatest Adventure" at two assemblies at Bloor Collegiate Institute, where he taught in 1964-65. On December 30 he was interviewed by *David Suzuki* on the CBC radio program *Quirks and Quarks*. The topic was "The Calendar". On January 14 John spoke on "News From the Universe" to the Ulyssian Society at Hart House.

*Barry Madore* addressed the Toronto Centre of the RASC in December on the subject of "Peculiar Galaxies" emphasizing recent work in the Southern Hemisphere.

*Martine Normandin* gave a talk on "Rotation Measures and the Galactic Magnetic Field" at Universite Laval on January 19.

*Rick McGonegal* helped a pack of Cub Scouts get merit badges in astronomy on November 30 with his talk, "Our Solar System and Beyond".

*Mary Lane* spoke on "New Developments in the Solar System" in the Baycrest Centre Celebrity Speaker Programme on December 14.

On January 18, 1979 *Barry Madore* addressed the Dept. of Astronomy at the University of Western Ontario on the topic of "Searching for Peculiar Galaxies on the New Southern Sky Survey.

#### PAPERS SUBMITTED

P. Biermann et al	Radio Continuum Observations of Markarian Galaxies at 1410, 2380, and 5000 MHz
P. Biermann et al	HI Observations of Active and Interacting Galaxies
P. Biermann et al	HI Absorption and Emission in the Interacting Galaxy NGC 2623

P. Biermann et al	HI Observations of SO Galaxies
K. Lake & R.C. Roeder	Note On the Optical Appearance of a Star Collapsing Through Its Gravitational Radius
C.W. McAlary, R.A. McLaren & D.R. Crabtree	Broadband Near-Infrared Observations of Seyfert Galaxies
S.N. Shore	A Study of the Helium Peculiar Stars of the Upper Main Sequence: I. A Generalized Model for the Helium Rich Stars
D.G. Turner	An Improved Reddening Transformation Relation for Wolf-Rayet Stars
M. Simard-Normandin & P.P. Kronberg	Some New Large-Scale Magnetic Features of the Milky-Way
J.R. Percy	The Light Variation of HR 9070
M.C. Lane & J.R. Percy	Studies of Beta Cephei Stars
S.M. Jakate	On the Photometric Variability of a Vel and of the He-Weak Star HR 3448
J.R. Percy et al	A Search for Light Variations in F and G Type Super Giants

COLLOQUIA\*

January 31	William Harris, McMaster University "Globular Clusters in Galaxies"
February 6 (Tue.)	David Crampton, DAO "The Distance to the LMC Using OB Stars" (At DDO, 4:00 p.m.)
February 7	Arne Slettebak, Perkins Obs., Ohio State Univ. "Be Stars"
February 14	Donna Zubrod and Mario Pedreros, University of Toronto G-2000 Current Literature Seminar
February 21	Judy Pipher, University of Rochester "Infrared Spectroscopy of H <sub>2</sub> Regions and their Molecular Clouds"
February 28	Nancy Houk, University of Michigan "Analysis of the New Henry Draper Catalog"
March 7	Gerry Grieve and Joan Wrobel, University of Toronto G-2000 Current Literature Seminar

\* Unless otherwise noted, colloquia are held on Wednesdays at 4:00 P.M. in Room MP 137 with TEA at 3:45 in the Reference Room, MP 1404.

## F I N A L I T E M

### *The Search for Vulcan. I.*

*We seek him here, we seek him there,  
Those Frenchies seek him everywhere.  
Is he in heaven? - Is he in hell?  
That demmed, elusive Pimpernel.*

More than half a century before the Baroness Orczy wrote those famous lines, Urbain Leverrier was unwittingly preparing to embark on his own celestial Odyssey. Director of the Paris Observatory, full of pomp and dignity, his name already inscribed in history for the discovery of Neptune, an 'uncomfortable bedfellow' (as his kinder colleagues put it) well-aware of his own brilliance, Leverrier had a particular dislike of frustration. Why, oh why did the transits of Mercury across the sun's disk not take place at the precise instants predicted for them? In a severe analysis of the problem, Leverrier concluded in a note to the French Academy of Sciences in the autumn of 1849 that the trouble could be traced to the advance of the planet's perihelion: the advance was 38 seconds of arc more per century than that predicted by theory.

Leverrier spent another decade mulling over possible explanations. Could it be that the neighbouring planet Venus had a mass greater than then believed, and so perturbed Mercury to a greater degree? No, because then it would also perturb the earth to an extent not observed. Much more likely, concluded Leverrier in another bulletin to the Academy at the end of 1859, that there exists a so-far unobserved planet between Mercury and the sun. It would soon be named Vulcan. General observation would be difficult because Vulcan would always be very close to the sun in the sky, but it might be (already have been??) seen transiting the sun's disk or rendered visible by a total solar eclipse. Such a clarion call to crankdom would not go unanswered.

First out of Pandora's box came a letter from M. Lescarbault, a country doctor, forwarded for some arcane nineteenth century French reason through the hon. inspector-general of roads and bridges, announcing that on March 26, 1859, about four in the afternoon, he had seen a round black spot moving across the face of the sun. Details followed. Leverrier was outraged. How dare so important an observation have gone so long unannounced? He rushed to the country, boiling himself into a state of draconian fury.

Richard Proctor, doyen of Victorian astronomical gossips, gives us details of the ensuing interview. "One should have seen M. Lescarbault, so small, so simple, so modest, and so timid, (Proctor quotes a witness) in order to understand the emotion with which he was seized, when Leverrier, from his great height, and with that blunt intonation which he can command, thus addressed him: "It is then you, sir, who pretend to have observed the intra-mercurial planet, and who have committed the grave offence of keeping your observation secret for nine months. I warn you I have come here with the intention of doing justice to your pretensions, and of demonstrating either that you have been dishonest or deceived. Tell me, then, unequivocally, what you have seen.' The lamb, trembling, stammered out an account of what he had seen.

He explained how he had timed the passage of the black spot. 'Where is your chronometer?' demanded Leverrier. 'It is this watch, the faithful companion of my professional journeys.' 'What! with that old watch, showing only minutes, dare you talk of estimating seconds. My suspicions are already too well confirmed.' 'Pardon me, I have a pendulum which beats seconds.' 'Show it me.' The doctor brings down a silk thread to which an ivory ball is attached. Fixing the upper end to a nail, he ... shows his pendulum beats seconds; he explains also how in his profession, requiring him to feel pulses and count pulsations, he has no difficulty in mentally keeping record of successive seconds."

Hardly mollified, Leverrier inspected the doctor's telescope and noted disparagingly that the observation had been recorded on a scrap of paper covered with grease and laudanum, currently serving as a marker in the doctor's almanac. Had the miserable doctor attempted any calculations as to the planet's orbit? He had, and being also a carpenter, he rummaged around his workshop to find the boards on which the calculations had been made with chalk. Leverrier dismissed them contemptuously.

A fine display of arrogance, but evidently Leverrier was secretly very pleased with the report. One can hardly imagine the surprise of the trembling lamb when, after due interrogation of the town's mayor as to his victim's general character, Leverrier arranged for Lescarbault to receive the Legion of Honour. Ah, mon Dieu, these astronomers ...

And so began Leverrier's crusade to find Vulcan, a crusade that he would pursue unfulfilled to the grave. At first, however, things went well. In Leverrier's capable hands Lescarbault's observation was made to yield what seemed reasonably reliable parameters for Vulcan's orbit. Its period of 19 days 7 hours would result in frequent transits, generally four a year, mostly between March 16 and April 21. Applause was widespread. "The singular merit of M. Lescarbault's observations" wrote *The Spectator* "will be recognized by all who examine the attendant circumstances; and astronomers of all countries will unite in applauding this second triumphant conclusion to the theoretical enquiries of M. Leverrier."

Unfortunately, the merit of M. Lescarbault's observations was rather less singular than expected. A French astronomer by the name of Liais, attached to the Brazilian Coast Survey, wrote to say that he had been observing the sun at precisely the same time as Lescarbault and with a better instrument, yet had seen nothing. His honour impugned, the trembling lamb became more lion-like, and a brisk exchange of views as to one another's abilities and characters broke out. Factions began to form. Leverrier stuck by Lescarbault; Flammarion and others supported Liais in scorning Vulcan's existence. Most waited, bemused, for the next predicted interval of likely transit, which clearly would be critical to the outcome of the argument.

Astronomer Royal Airy, mindful that the sun never set on the British Empire, arranged for British observations to be made from the Far East and Australia, through India and Africa to the Americas. Observers in general stood by their telescopes ready to skewer Vulcan. The results? All negative. Nothing was seen.

But if the professionals weren't up to finding Vulcan, there were plenty who were. None less than the City Chamberlain of London had seen the planet, as did another Englishman, M.W. Lummis. Such sporadic reports would plague Leverrier for years to come. A seemingly reliable German in China sent in a report that came close to fitting Leverrier's predictions. Rather less reliably, Mr. Tice, of Louisville, Kentucky, who somehow needed Vulcan's existence for a remarkable theory of the weather, claimed a quite definite observation.

The curse of all these claims lay in the fact that there might be more than one intra-mercurial planet. One could not dismiss the observations on the grounds of their failing to meet predictions. And so for years and years Leverrier slaved over his log tables, analyzing new possibilities, making new predictions. Such was his character, he could not bring himself to believe his whole idea wrong, and his irritation and frustration continually worsened in the face of rampant scepticism among the astronomical community. His old enemy , Pierre Janssen at Meudon, took the opportunity to point out that astronomy's new tool, photography, would surely by now have discovered Vulcan if it existed.

And so it went to the day of Urbain Leverrier's death on September 23, 1877. More than twenty years of work for nothing. And then, ten months later, the world was electrified by the news that Vulcan had been discovered independently by two highly respected astronomers in the United States during a total solar eclipse.

JDF