



DAVID DUNLAP DOINGS

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A KIRKWOOD GAP

(see Final Item p. 7)

EDITORIAL

Eric Lindsay and Armagh Observatory

At the end of last month we had word from Peter Millman that Eric Lindsay had died suddenly in his office at Armagh Observatory in Northern Ireland where he had been Director since 1937. Peter and Eric were good friends, having been graduate students together at Harvard in the early 1930's. Helen Hogg also knew Eric quite well at that time, as well as Sylvia Mussels, the American girl whom he married (Carl Seyfert having married her sister, Marian).

I first met Eric Lindsay at the 1955 IAU General Assembly in Dublin. The Sunday Excursion of that meeting was a visit by "radio train" to Armagh. The radio train turned out to be a train in which all the coaches were provided with loud-speakers playing music transmitted from Belfast, interspersed with announcements about the countryside and the towns we passed through. At the time it was apparently considered to be a notable technical achievement. During our few hours in Armagh we were the guests of Eric and Sylvia at the Observatory, and of the Church of Ireland Archbishop and the Roman Catholic Cardinal in their respective cathedrals in the town centre - both cathedrals dedicated to St. Patrick who is said to have founded the see (and some say also the town) in the 5th century.

I had a more leisurely visit to Armagh Observatory in 1963 when my wife and I were guests of the Lindsays for a half-day. Eric had grown up on a farm only a few miles from Armagh. On our way from the train station in Portadown Eric took us to the gracious old farm house which was then owned by his older brother. The Observatory, just on the outskirts of Armagh, is one of those old-style buildings with a few domes, a few offices and a wing containing the living quarters for the director. However, at that time they had just started to build a new building which was to have a library, three offices and a room to house their newly acquired Sartorius photometer.

The oldest Armagh telescope (a two-inch refractor with enormous position circles) dates from 1794, which I suppose is the date of the founding of the Observatory. They also had a 9-inch refractor and a 32" - 36" Schmidt, but I gathered that neither of these was in regular use. Eric Lindsay devoted his research time to observing with the Armagh - Dunsink - Harvard 32" - 36" Schmidt at the Harvard Boyden station in South Africa. He spent frequent long sessions there and brought back to Armagh direct photos and objective-prism plates of the Magellanic Clouds for photometry and recognition of clusters and H-alpha objects. The ADH Schmidt was then being used also by Swedish and German astronomers who, however, were at that time thinking of giving it up because of their involvement in ESO. Lindsay suggested that the Canadian astronomers might do worse than to opt into the ADH operation; he had little

faith in the Commonwealth telescope which Woolley was just then mooting, and he was outspoken in his criticism of the Isaac Newton telescope venture, his having been the only dissenting voice at the meeting of British astronomers which voted it in just after World War II.

Lindsay's only colleague then was Ernst Opik, the brilliant and colourful Esthonian who had made Armagh his home base after being forced (I suppose) out of Esthonia after the war. It was interesting to observe the easy friendship and mutual respect of these two men of such different backgrounds, interests and ages (Opik much the older).

In these and a few other meetings I formed an impression of Eric Lindsay as a charming, intelligent, tolerant Anglo-Irish gentleman who was making an excellent job of one small example of the transition from the old to the new astronomy. I feel that if there were enough with his qualities on the political scene in Northern Ireland peace might finally come to that unhappy land.

J. F. H.

OBSERVING

(in a way)

The microdensitometer

As announced in the last DDD, the new microdensitometer has arrived. It is currently undergoing acceptance tests. After some initial problems, the computer and data acquisition system have been fully checked out. Some shipping damage to the microdensitometer will be repaired next month. The system is usable in the meantime. Tom Bolton, Jim Thompson, Austin Gulliver, and Bruce Campbell went through the two day operation and maintenance training program provided by the manufacturer during installation. They will take the initial responsibility for the system. Mr. Alex Hay (Physics M.Sc. UWO) will be joining the staff as the microdensitometer operator and computer programmer on September 2. Further information on the microdensitometer system will be distributed as soon as it becomes fully operational. In the meantime please address all questions to Tom Bolton.

C. T. B.

COMINGS AND GOINGS

AAS

According to the best information available at press time, Bob Garrison, Tom Bolton, Sidney van den Bergh, Bill Herbst, Helen Hogg, Don Fernie, Rene Racine and John Sorvari were to be attending the AAS meeting in Rochester last week, Tom giving a lead-off paper on Optical Observations of X-ray Binaries, and Bill a paper on "R-Associations, Local Spiral Structure and the Ratio of Total to Selective Absorption".

Arctic

Helen Hogg has just returned from an unsolicited and non-astronomical visit to, of all places, Frobisher Bay, followed by ten days at her Dunstable place.

Palomar

Sidney van den Bergh was observing at Palomar Aug. 11-21 after a two-day visit to Victoria.

Steward and Queen's

Peter Martin observed at Steward Observatory Aug. 1-7 and then went to Queen's for the Aug. 8-10 Queen's Summer Institute for Theoretical Astronomy.

Md.

Don Fernie was at the University of Maryland July 30 as an external Ph.D. thesis examiner and gave a colloquium on "History of Ideas concerning Interstellar Matter".

CFHT

Bob Garrison has been invited to take part in the discussions of the CFHT Working Group on Spectrographs in Marseilles Aug. 26-29.

SEMINARS

August - None !

September - Any ?

PAPERS SUBMITTED IN AUGUST

R.C. Roeder
et al.

On the Behaviour of Spacelike Geodesics in the Extended Schwarzschild Manifold.

C.T. Bolton Orbital Elements and an Analysis of Models for HDE 226868
 = Cygnus X-1

" The Strange Case of HD 107325

R.G. Deupree On the Treatment of Convection as a Non-Radial Stellar
 Pulsation

J.F. Heard & The Orbit of the Double-Line Spectroscopic Binary HD 153720
R.J. Hurkens

P O T P O U R R I

Born

To Martin and Nancy Evans a daughter, Catherine, on Aug. 13.

To Robert and Sheila Smolkin a son, Joel David, on Aug. 3.

Degrees

In our confusion I fear that we overlooked the awarding of the degree of Ph.D. on June 10 to Gretchen Hagen and Jack Winzer. Apologies and Congratulations to both.

Recovering

Joan Hawker is recovering from surgery for a serious stomach ulcer on Aug. 15.

Appointments

Bill Herbst has accepted an appointment as Lecturer and Post-doc at York, technically as of July 1, actually Sept. 1. Bill and Betty will move closer to the York Campus, but Betty will continue as research assistant here.

Dale Ogden has accepted an appointment as assistant secretary at the Observatory and has been working hard and cheerfully at it since July 29.

GASA Picnic

This year the GASA picnic was held on Aug. 15 right at home on the south lawn and it was great - big attendance, lots of family, hamburgers, hot-dogs, salads, beer, games, ants and a small white dog.

Married (future pluperfect)

Between the time this is printed and you read it, Gretchen Hagen and Bill Harris will have been married; but we'll tell you more about it next month.

Visitor

Dave Crampton (Ph.D. 1967) of DAO visited his sister in Richmond Hill and the Observatory on Aug. 20 on his way to the AAS and to France for a CFHT meeting.

Interviewed

Bob Garrison was interviewed recently for CBC Radio on "Life on Other Worlds".

New Students

Andrew Leir of U. Vic and Thor Prociuk of Laurentian have arrived to begin their graduate studies in the Department.

Quote

Don MacRae has spotted in the Aslib Book List a review of "Variable Stars in Globular Clusters" which speaks of a special section devoted to RR Lurae Variables. Quoth Don: "Lura is the constellation that the lurid meteors appear to come from".

Centenarian

Donald MacRae's mother reached the milestone of 100 on August 11. The family celebrated the occasion with her and her friends at a party in King where Don's sister and her husband, Mr. and Mrs. Henry Borden live. On the following day there was another celebration at Central Park Lodge in Toronto where Mrs. MacRae Sr. lives.

Mrs. MacRae, daughter of a prominent Nova Scotian family named Barnstead, was married in 1900 and lived mostly in Halifax where Dr. MacRae Sr. was Dean of the Dalhousie Law School from 1914 to 1924. In 1924 Dr. MacRae accepted a teaching post at Osgoode Hall, and the family came to Toronto.

Among the many greetings received by Mrs. MacRae were messages from the Mayor of East York, the Premier of Ontario and Her Majesty the Queen.

FINAL ITEM

The American Kepler

Astronomy 100 students are, of course, unfathomable. On the exam which concludes their course they will happily report to their bemused instructor that Tycho Brahe is famous for proving the earth to be spherical, or that William Herschel invented the expanding universe, but for some curious psychological reason they almost always manage to get Daniel Kirkwood straight. He is definitely the guy who found the gaps in the asteroid belt. I don't know why this is, but perhaps it is sufficient to reflect that if most A100 students can recall correctly just what one did, one must be famous indeed.

However, ask even the average A100 instructor what else Kirkwood achieved in his career and you will likely be met with blank silence. Kirkwood's Gaps yes, but anything else?? The remarkable thing is that long before he found those gaps Kirkwood made another discovery that caused such established luminaries as Benjamin Gould and Benjamin Peirce to hail him as the equal of Kepler, and the discoverer of one of the most profound laws of the solar system. Newspapers, magazines, scientific journals reported the sensational discovery in highly laudatory manner, Kirkwood received two honorary degrees on the strength of it, and later achieved professional positions that he almost certainly would not have achieved otherwise. Yet such is the nature of the game that the whole business has long since been forgotten.

Part of the reason for the high praise stirred up in the American press by Kirkwood's discovery was that the story was very much in keeping with the American Dream, the American Way. Here was a man who had started as a farmboy, who had had only a poor education, and yet who had struggled up the ladder to become the discoverer of a major law in mathematical astronomy. Daniel Kirkwood had indeed been born (in 1814) on a Maryland farm, and his only education as a child came from the local country school. At the age of nineteen, having no taste for farming, he became a schoolteacher in another such country school. One of his students wished to study algebra, and since Kirkwood knew no algebra, he and the student sat down and worked through a textbook on the subject together. From this Kirkwood realized that he had both a flair and a taste for mathematics, and so went back to school himself for several years to study the subject. By 1849 we find he had worked his way up from being a mathematics instructor to becoming the principal of an institution which rejoiced in the name of the Pottsville Academy of Pennsylvania. It was about this time that he made his discovery.

In as few words as possible Kirkwood's great discovery was this. For reasons connected with Laplace's Nebular Hypothesis, Kirkwood felt that just as the revolutions of the planets about the sun are not random but are governed by Kepler's laws, so too their rotations or spinning on their own axes should be related in some way. Lacking the mathematical ability to tackle the problem analytically, and undaunted by the fact that Laplace himself - one of the greatest celestial mechanics in history - had never made mathematical progress with the Nebular Hypothesis,

Kirkwood spent ten years looking for empirical correlations between the planets' rotations and various other properties. Finally, in the late 1840's, he arrived at the following. Consider three consecutive planets lined up in a row. There will be a point between the middle and outer planet at which a particle will experience equal gravitational force from the two planets, and another such point between the middle and inner planet. Call the distance between these two points D , the 'sphere of influence' of the middle planet. Next, from the known periods of rotation and revolution calculate the number of rotations n that a planet makes in the course of one revolution. Kirkwood's discovery was that when this was done for all the planets, $n^2 \propto D^3$. (If you would like to see a mathematical summary of this, along with the actual numbers used, you will find one in A. N. ³⁰ 11, 1850).

Unlike many a discoverer of a scientific law (Kepler, for instance, prancing around in paeans of ecstasy as to how God had waited 6000 years for someone to discover that third law), Kirkwood behaved in exemplary fashion. He wrote in very modest fashion to Edward Herrick at Yale, describing his discovery, but noting that "perhaps it may be regarded by those better qualified to judge than myself, as a vagary not worthy of consideration". Herrick suggested that he send it to an astronomer at the U.S. Coast Survey, Sears Walker, then well-known for his work on Neptune's orbit. Walker discussed the finding with other members of the American Philosophical Society, and soon became an enthusiastic advocate, telling Kirkwood that it "deserves to rank at least with Kepler's harmonies", and offering to steer it through publication. Walker found a way of using the relation to calculate that the original planet from which the asteroids were supposed to have come must have been about 5000 miles in diameter and had a rotation period of $57\frac{1}{2}$ hours; he decided to name it 'Kirkwood'.

Even now Kirkwood hesitated, asking Herrick's advice as to whether he thought the paper worth publishing. But Walker's enthusiasm prevailed, and in August 1849 the discovery was made public through a paper given by Walker to the AAAS. He hailed it as "the most important harmony in the Solar System discovered since the time of Kepler, which, in after times, may place their names, side by side, in honorable association". Walker was soon joined in his eulogies by other important American astronomers, notably Gould and Peirce. Ben Gould was soon writing extravagant comparisons of the lives of Kepler and "Mr. Kirkwood, a teacher in the interior of Pennsylvania". With the discovery given the stamp of approval by America's leading astronomers, the general press were soon in full cry and adding their wild praise.

On the other side of the Atlantic the reception was rather different. With the element of national pride removed, and the Nebular Hypothesis being then in disfavour, most European astronomers were coolly sceptical, although there were some, like David Brewster, who admired Kirkwood's result. But the majority opinion can be gauged from the reaction of Schumacher, the editor of the *Astronomische Nachrichten*. In printing Walker's paper on the subject (the reference given above), he added a footnote at the end declining comment on the paper, since each reader could "judge for himself how much ... is really factual and how much is simply hypothetical".

Does the $n^2 \propto D^3$ relation really hold water? When you get right down to it the statistics become rather few - not that that has ever stopped an astronomer of course. Pluto was not then known, Neptune and Mercury fall away because one cannot calculate D for them, and Walker notwithstanding, the asteroids foul up the calculation of D for Mars and Jupiter. That leaves only four planets, and if you look at the numbers in Walker's paper you find that they have hardly the values we would assign them today. Investigations of planetary masses (needed for D) had a long way to go, while knowledge of some planetary rotation periods were hazy, to say the least. Venus, for one, is assigned a rotation period of 1 day. So it was really just an accidental correlation caused by too few and too inaccurate data. Poor Kirkwood; he once wrote, in a tone highly reminiscent of today's Ap J papers, that he was sure it was real because he had calculated statistically that the probability against its being accidental was many millions to one.

And what of Kirkwood's later life? The initial sensation of his discovery made him much in demand among educational institutions, and he eventually spent some thirty years as professor of mathematics at Indiana University. Even after he had retired to California he was still, aged 77, a lecturer in astronomy at Stanford University. It was in California that he died in 1895 at the age of 80.

The first of his papers on the famous Kirkwood Gaps was published in 1866, and in later years he was well-known for his work on meteors and comets. He was, for example, probably the first to offer solid evidence of the relation between comets and shower meteors. Even so, one gathers that there were those among his contemporaries who never regarded him as much more than a parvenu. I think not, but be that as it may, we may note the words of one of his biographers: "Kirkwood was an immensely popular, enthusiastic, and inspiring teacher". Few indeed are the professors of whom that can be said.

J. D. F.

