ARGELANDER AND THE BONNER DURCHMUSTERUNG

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ABSTRACT

A brief account is given of some aspects of the life and work of F.W.A. Argelander, with particular reference to the compilation of the *Bonner Durchmusterung*.

RÉSUMÉ

Un bref compte-rendu de quelques aspects de la vie et des travaux de F.W.A. Argelander est donné, incluant des références particulières à la compilation du *Bonner Durchmusterung*.

S.P.

Most people, these days, think of Bonn as the capital city of what was, until very recently, West Germany. John Le Carré set one of his spy stories in and around Bonn, and gave it the rather disdainful title of "A Small Town in Germany". The slur is somewhat unfair to a city that can boast a fine Romanesque cathedral, to say nothing of the house where Ludwig van Beethoven was born. In addition, astronomers associate the city with the name of Friedrich Wilhelm August Argelander (1799–1875) and his great project of the *Bonner Durchmusterung* – a catalogue and chart of all stars down to about ninth magnitude that are visible from Bonn.

Argelander would probably be as surprised as anyone to find that this chart and catalogue are still used, nearly 150 years after he began work on them. His aims were to construct a chart accurately enough for it to be useful in identifying minor planets and to help the amateur observers whom he was anxious to enlist in the study of variable stars. His methods were simple, almost crude, but their execution – with the help of E. Schönfeld and A. Krüger – was so careful that many astronomers used both the catalogue and the charts. We still use "B.D. numbers" for stars too faint to be in the *Henry Draper Catalogue* of spectral types (produced at Harvard) and many of us still use the maps to make our own finding charts for observing stars of eighth or ninth magnitude. Of course, the B.D. is of no use for large telescopes observing much fainter stars, but users of moderate-sized telescopes will probably continue to use it indefinitely far into the future, despite the minor inconvenience of its 1855 coordinates.

A recent holiday in the Rhineland gave me a chance to visit Bonn and to see the observatory and telescope with which the *Durchmusterung* was made. Argelander was appointed professor of astronomy in the University of Bonn in 1837. He

succeeded in obtaining a considerable sum of money to build and equip an observatory partly because, apparently, he was a good friend of Friedrich-Wilhelm IV of Prussia – a man about his own age. The Observatory was originally known as the Royal Observatory of Bonn, and was built on a royal scale. Wilhelm Struve (1860) described it as a "beautiful observatory" and I was curious to see it for myself. The building is now occupied by a quite different department of the University: all the domes and turrets are empty. We were able, however, to climb the quite long flight of stairs to the main dome. The astronomers of Bonn now have an Institute in the suburbs, in a building which they share with a branch of the Max-Planck Institute, and a modern observatory at Hoher List some distance to the south of the city. Two of Argelander's instruments are still preserved in the Institute – his heliometer and the small telescope (originally intended as a comet-seeker) used for the *Durchmusterung*. I had always known that it *was* a small telescope, but I was taken by surprise when I saw how small. Argelander (1859) described it as of "34 lines aperture, 24 inches focal length and ten-times magnification". The *line* was one-twelfth of a Paris inch, or about one-tenth of an English inch. The telescope, then, is about three-and-one-half English inches (9 cm) in aperture and not much more than 60 cm long. Even by mid-nineteenth-century standards, this was a very modest instrument to use in a major observatory project. In fact, the B.D. was not compiled only from observations made with the small comet-seeker. Argelander soon left the lion's share of work with it to Schönfeld and Krüger, and used the meridian circle to check the coordinates of stars left doubtful by the work with the small telescope. Later, Schönfeld and Krüger also used large instruments to check and revise; later still, Schönfeld (1886) extended the B.D. to declination 23°S (the practical limit from Bonn) and used a larger telescope to compensate for the greater atmospheric extinction. The basic observations for the entire sky north of declination 2°S were, however, made with the small comet-seeker.

Argelander had had a good training in the positional astronomy so basic to the work of nineteenth-century observatories. In the 1820s, he spent some years in Königsberg (now Kaliningrad) as Bessel's assistant and then worked in what is now Finland as director first of the observatory in Åbo (Turku) and then of that in Helsingfors (Helsinki). Finally, he came to Bonn, where he remained for the rest of his life. He was, perhaps, the first modern astronomer to recognize the importance of the systematic study of variable stars. As is well known the Chinese recognized the variability of at least novae and supernovae long before European astronomers did. Even in Europe, the variability of a few stars had been recognized, and the periods of Algol, β Lyrae and δ Cephei determined (Goodricke 1783, 1785), before Argelander was born. By the time he had grown up, however, there were still only a few variables known – and they were little studied. In 1844, Argelander issued an appeal to all "friends of astronomy" which

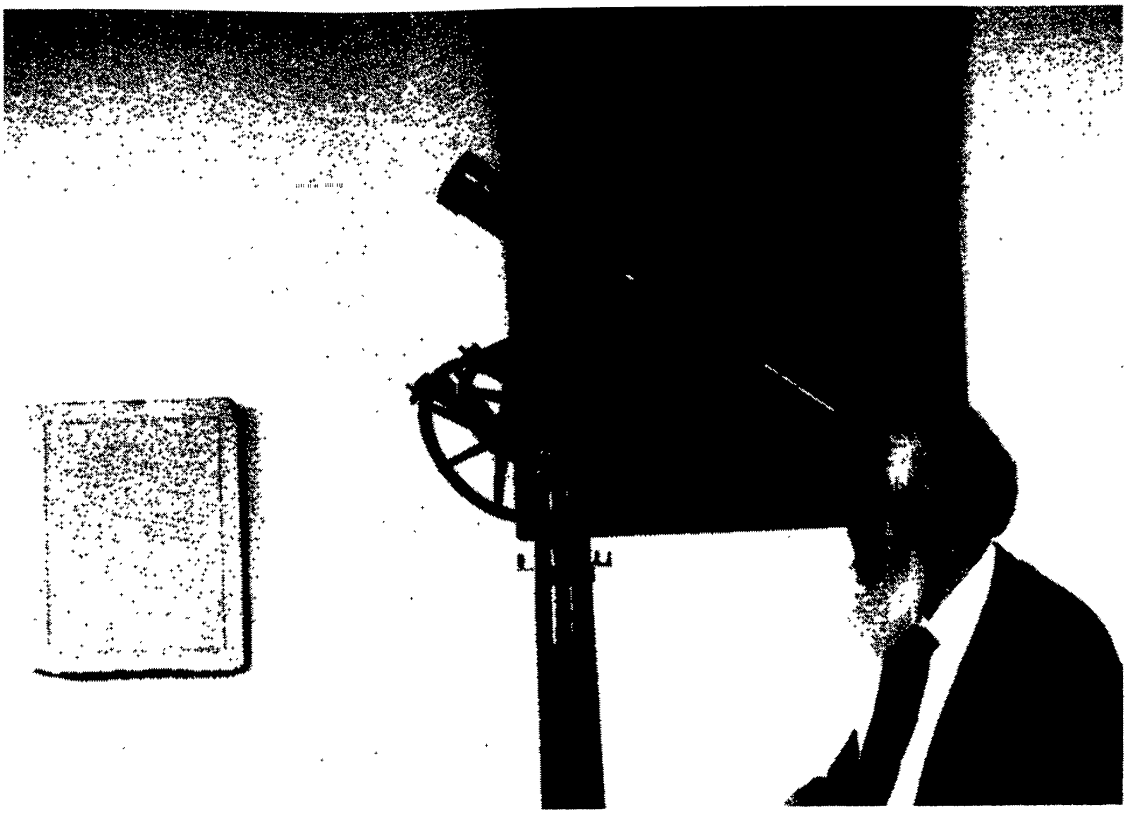

FIG. 1—The writer admires the telescope that made the *Bonner Durchmusterung*. From the wall, a portrait of Argelander looks down. To the left, set in the wall, is one of the original stone blocks used in printing the charts. *Photograph by Lois Batten.*

was a request to amateur astronomers to do exactly what so many of them now do – monitor the behaviour of variable stars, especially the irregular ones, so that professional observers could be alerted when something unusual occurred. When E.C. Pickering took the lead in founding the American Association of Variable Star Observers, he was consciously influenced by this appeal from Argelander, who, once again, would probably be surprised at the extent of his influence through both space and time.

Argelander devised the nomenclature that we still use for variable stars. The first variable (other than the few with Bayer designations) discovered in each constellation is denoted by R followed by the *genitive* of the constellation name. The next was S and so on to Z. Apparently Argelander chose R because it was the first letter of the alphabet that had *not* been used in any earlier cataloguing. He soon found that nine letters were insufficient in many constellations and so used RR . . . RZ, then SS . . . SZ to ZZ. After that came AA . . . AZ, BB . . . BZ etc. Even Argelander probably did not foresee the discovery of thousands of variables in some constellations, necessitating the notation V335 etc., after QZ had been reached. It is interesting to note how many of the single-letter designations are

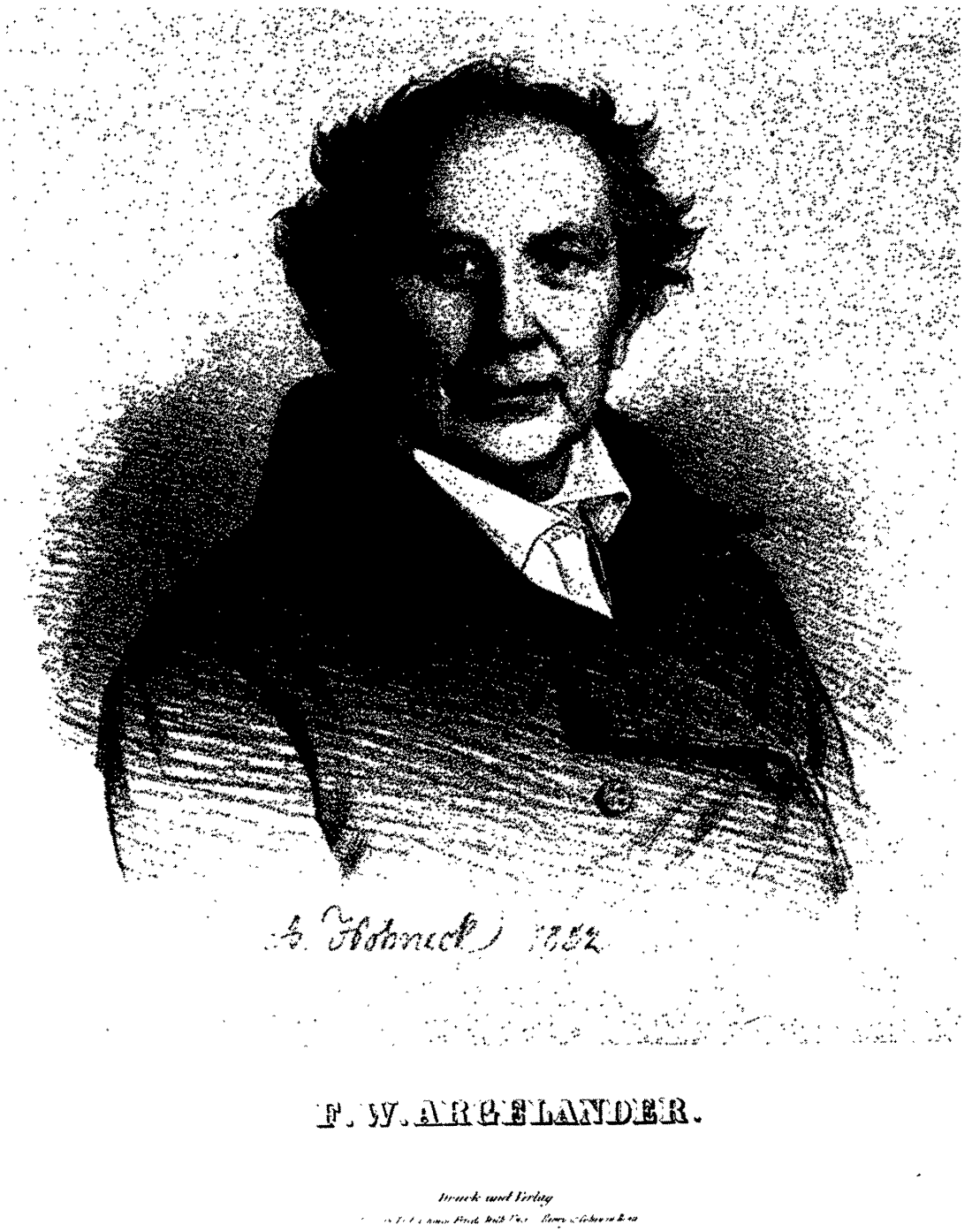

FIG. 2—Crayon sketch of Argelander by A. Hohneck. The original belongs to Bonn Observatory. This is copied from a lithograph now in the possession of the writer.

eclipsing variables: R Canis Majoris, S Equulei, T Leonis Minoris, U Cephei, V Puppis, W Ursae Majoris, X Pictoris, Y Cygni and Z Vulpeculae are only some examples. Most of these are Algol-type systems, whose short periods and deep eclipses make their variations relatively easy to detect. That so many of the earliest variable stars to be detected were eclipsing, is a good example of observational selection.

In compiling the B.D., Argelander made a conscious break from earlier methods of making charts. Other observers had entered each star on paper ruled with a coordinate grid, while they were at the telescope. Argelander recognized that this was inefficient and would, in particular, prevent the observer from adapting his eyes properly. He arranged, therefore, always to have two observers; one at the telescope and the other in a lighted room below. The telescope could be set to a given declination for several hours at a time – even for the entire night – because stars were recorded in declination zones. The telescope had a wide field of view, and the observer would record the transits of all stars within a band near the middle of the field slightly more than 2° wide (increased to 6° for declinations above about 50° N, where the sky drifted more slowly past the observer's field of view) centred on the telescope's nominal declination setting. This observer had to record the extent and sign of each star's deviation from that nominal setting. Argelander went to some trouble to design a pad on which the observer could enter the necessary figures in columns, without having to remove his eye from the eyepiece. Another problem was to make the reticle visible (without artificial light) so that the observer *could* estimate declinations. After trying several ideas, Argelander finally marked the divisions with strips of "thick black oil-paint" that were "admittedly rather uneven and about 1′.5 wide" but "the results have shown" that "in all, only a very insignificant [degree of] accuracy was lost." Argelander (1859) continued (my own translation):

> The observer proper, whom we may designate A, sat or lay, according to the altitude of the zone to be observed, on a chair, the moveable back of which could be so placed that his eye would be immediately at the eyepiece, with his body in a completely comfortable position and, without having to move himself in or out significantly, he could in comfort survey rather more than 2° of declination. There was no artificial light in the room, and the eye was protected from the outside light of the sky by a black cardboard shield, that was fixed to the telescope at the eyepiece end and counterbalanced by a ring at the objective end. To protect the eyepiece from mist, or even more to remove at once any trace of it, the mounting [of the eyepiece] was pierced at two opposite points and connected by a rubber hose to a pair of bellows. A couple of pulls on a cord, by which the spring-loaded bellows are set in motion, suffice to achieve this goal. Under the observing room, separated from it only by the floorboards, in a second [room] is a clock (Tiede No. 37) showing sidereal time, before which the second observer, B, sat, so that he had the clock face immediately in front of his eye.

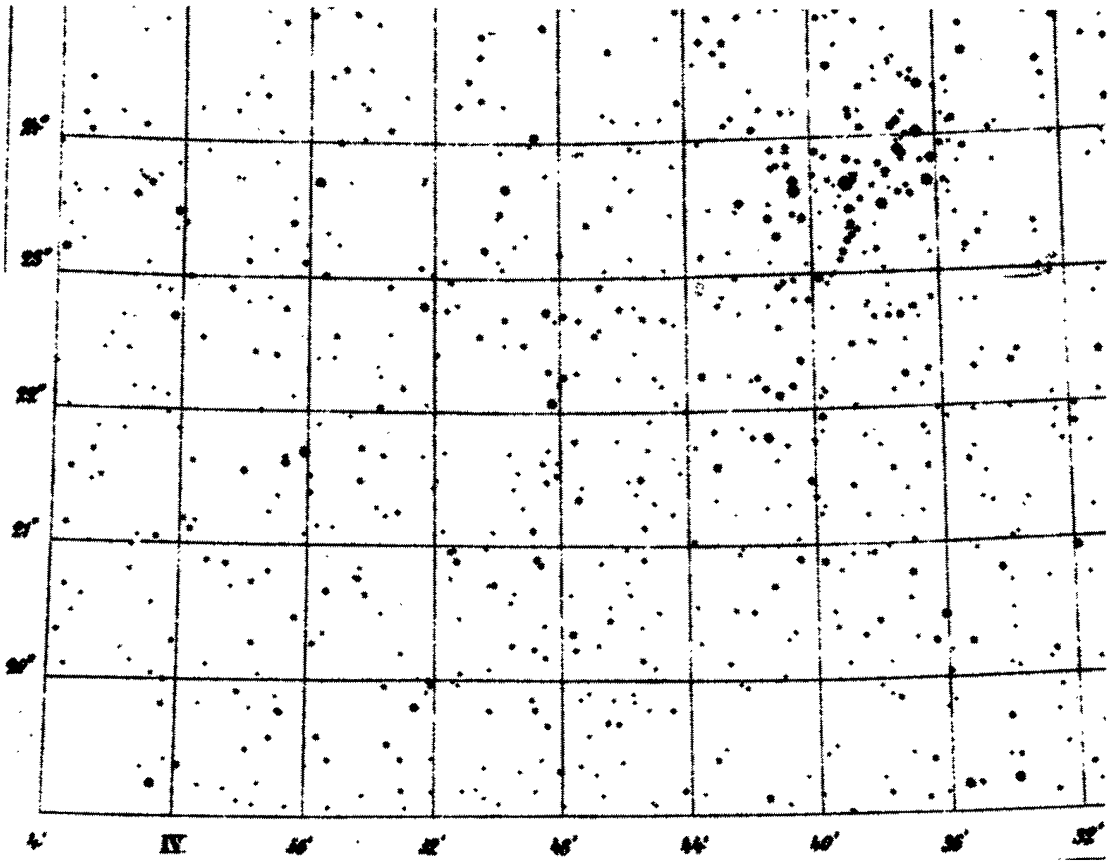

FIG. 3—Portion of the B.D. chart that shows the Pleiades. This is copied from the Dominion Astrophysical Observatory's copy, which is itself a half-size photographic reproduction of the Lick Observatory copy.

The system was: A noted down the difference between the telescope setting and the star's declination and shouted out to B the estimated magnitude (in a pre-arranged code) as each star transited the meridian: B then wrote down the time of transit and the magnitude. Stars of known right ascension were observed, at least at the beginning, to check the clock. In addition B would make a mark on his record each time A got to the end of a page. Other marks were made whenever there was reason to fear that a call had not been heard, or that an extraneous sound had been mistaken for a call. Every zone was observed at least twice. There is a strong tradition that A would stamp on the floor as a star transited and B would then note the time. I have heard the story many times and it was repeated to me in Bonn. In the building where the work was done, one is very inclined to believe that stamping on the floor would have been a quick and effective way of communicating. The story does not seem to come from Argelander's written account – perhaps he thought that the bellows, rubber hose and thick black oil-paint were all that contemporary colleagues would swallow! If Argelander's aim was to keep observer A lying or sitting comfortably and still, however, stamping of feet would

be neither convenient nor encouraged – and A would still have to shout out the magnitude. My guess is that A would indeed sometimes attract B's attention with a stamp, but that this was not part of the regular observing protocol.

People sometimes talk of errors in both the positions and magnitudes of the B.D. Argelander was not trying to make a fundamental catalogue and aimed only for a precision of one arc-minute in each coordinate and of half a magnitude in brightness. According to Lindley (1955), who based his claim on Pannekoek's (1924) analysis, Argelander exceeded his expectations. He himself estimated that errors greater than 4^s in R.A. and $2'$ in declination were rare. As Schönfeld and Krüger gained experience, they refined their magnitude estimates (see a letter from Schönfeld published by Peirce 1896). If you use B.D. magnitudes expecting uncertainties of $0^m.5$, you will rarely be misled, except among the faintest stars. Argelander did not aim for completeness below ninth magnitude, but did include many stars down to about tenth. The catalogue contained some 325,000 stars. When Küstner (1903) published a second edition, he corrected the positions for 600 stars and the magnitudes for 200. He added 727 stars, of which 98 had been missed because they were variable and only 28 were of ninth magnitude or brighter. He deleted 61, of which only 16 were of ninth magnitude or brighter.

If he had worked forty years later, Argelander would probably have used photography. Work on the *Carte du Ciel* did begin just over 100 years ago, but the project was controversial and too ambitious and was never completely successful. Southward extensions of the B.D. were made from Córdoba (Argentina – Thome 1892) and from the Cape Observatory (Gill and Kapteyn 1896). The former was made by Argelander's methods, the latter photographically. C.H.F. Peters, working in the United States, produced some very detailed charts and the Franklin-Adams photographic charts were also useful. Nothing, however, really superseded the B.D. until the National Geographic Society – Palomar Observatory Sky Survey was made in the early 1950s and large telescopes needed charts going well below Argelander's magnitude limit.

There are two lessons to learn from the story of the B.D. First, even quite minor instruments can do important things. No one is likely to use a 10-cm refractor for a major programme today, but instruments in the range of 30-cm to 1.5-m aperture are often used and can do some things better than much larger telescopes can. We should be careful that our efforts to obtain the largest practicable instruments do not draw funds from the construction of smaller ones, or, worse, absorb the operating funds of already existing telescopes. The second lesson is more personal. Argelander was a highly competent astronomer but he was not at the "cutting edge" of nineteenth-century research. He apparently did not aim to be the first to achieve some new observational break-through, nor is he associated with new basic ideas. But he did have a clear vision of some of the things that were important for the fuller development of astronomy in his time and, in a quiet

efficient way, he set about doing them. As a result, we remember him along with the great nineteenth-century astronomers and that, no doubt, would gratify him. He must be even more pleased, however, that we still find his work useful.

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