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An atlas of representative stellar spectra from 4870 to 3300

Huggins, William

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Chapter V.

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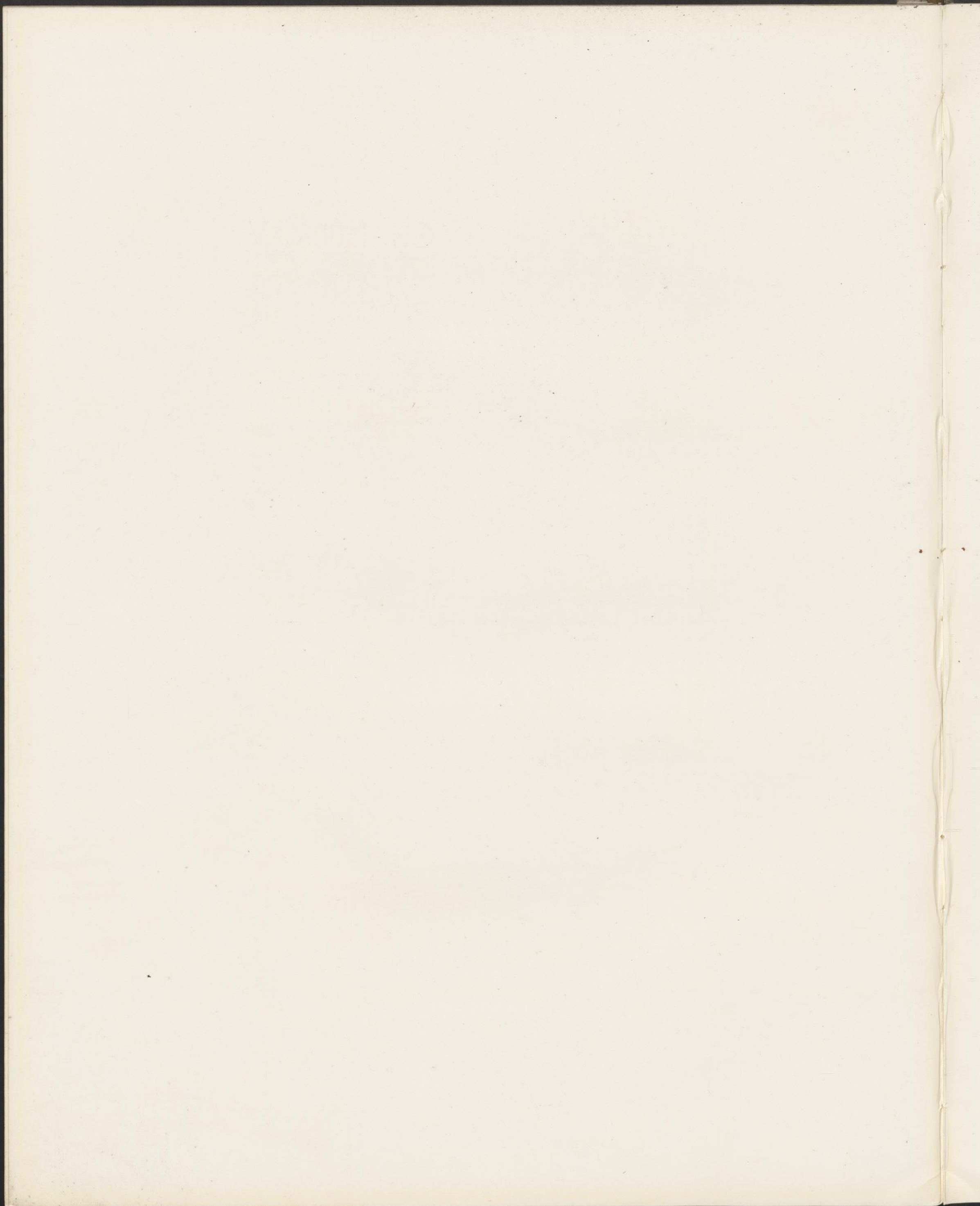
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CHAPTER V



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DESCRIPTION OF THE AUTOMATIC ARRANGEMENT BY WHICH THE NECESSARY BREADTH WAS GIVEN TO THE STELLAR SPECTRA ON THE PHOTOGRAPHIC PLATE



DESCRIPTION, as follows, of automatic methods of giving breadth to a stellar spectrum on a photographic plate was sent by me to the *Astrophysical Journal* (vol. v., p. 8, Jan. 1896) in 1896.

In my original paper on the "Photographic Spectra of Stars" * I point out that the necessary breadth may be given to a photographic spectrum, without the use of a cylindrical lens, by simply causing the star's image to travel slowly in the direction of the length of the slit. At present it is usual, the length of the slit being fixed in the direction of the star's motion, and the rate of the clock slightly fast, to cause the star to travel slowly along the slit, and when it has passed through a distance corresponding to the breadth which is desired for the photographic spectrum, by means of the slow-motion arrangements of the equatorial to bring the star back to its first position; and in this way, by a sufficient number of runs of a fixed length, to make up the time of exposure which may be required. Without the assistance

* *Phil. Trans.*, 171, Part II., p. 672, 1880.

Initial.—View from the Observatory. Drawn by Lady Huggins.

of an efficient electric control on the speed of the clock, this periodical bringing back of the telescope during a long exposure becomes very irksome, and brings in a serious loss of time. Even if the telescope is provided with a modern electric clock control, the method of successive runs by hand is troublesome and fatiguing, with the long exposure so often necessary.

A few years ago an automatic arrangement suggested itself to me by which any desired amount of breadth could be given to photographic spectra without interference by hand, except so far as may be required by change of atmospheric refraction, or from error of the clock rate. In this plan of working the clock must not be fast, but accurately adjusted to the motion of the stars, so that the star's image would remain fixed at any point of the slit at which it was put. Then, by means of an adjustable eccentric cam, introduced between the clock and the driving screw, the stellar image is made to oscillate backwards and forwards about its mean position to any extent that may be desired. It is necessary to have the means of adjusting the amount of eccentricity to the breadth of spectrum desirable with the spectroscope which is in use; and also the means of removing, at pleasure, the eccentric motion when it is not required.

I took some spectra by this method some years ago, but the wheel which I then employed could not be made sufficiently eccentric. Recently I have had constructed a very simple eccentric arrangement which fulfils these conditions.

The clock-motion on its way to the driving-screw passes through two wheels gearing into each other, of the same diameter and of the same number of teeth. One of the wheels is provided with a cam by which the axis can be moved outside the centre of figure of the wheel. This is effected by moving a small lever on the front of the wheel, which can then be fixed by a clamp in a position corresponding to any desired amount of eccentricity or breadth of spectrum, within the range furnished by the cam. It is only necessary to bring back the lever to its first position, and to screw up the clamp, to make the wheel concentric, when the clock-motion will be transmitted to the driving screw without alteration of rate.

It is obvious that when the wheel is made eccentric, the star will slowly travel to and fro about its mean position. The time required to make a complete revolution in my instrument is about two minutes.

It should be pointed out that as the teeth of the eccentric wheel alternately approach and recede from the other wheel during each revolution, the teeth of both wheels should be long and suitably shaped, so as to allow of considerable interpenetration when the centre of figure of the eccentric wheel is on the side of the axis which is nearer to the other wheel.

the Photographic Plate ✓

When such an eccentric wheel is employed the exposure increases towards the end of the runs—that is, towards the two edges of the spectrum.

This arrangement by means of an eccentric wheel has been given up in favour of a simpler device, by which the exposure remains uniform throughout the extent of motion which is necessary to give the required breadth to the spectrum. The two wheels gearing into each other, through which the clock-motion passes, on its way to the driving screw, are both concentric and of the same diameter, but one of the wheels has not the same number of teeth on both halves of its circumference. One half of the circumference of this wheel is furnished with one tooth more, and the other half with one tooth fewer than the number required to transmit the clock-motion without alteration of rate. The number of teeth on the first wheel of the pair is 50, so that one half of the second wheel has 24 teeth, and the other half 26; this difference in the number of the teeth is too small to interfere with the good gearing of the two wheels. It is obvious that after one whole revolution of the wheels, provided the clock-rate has been accurately adjusted, the star's image on the slit will be again precisely at the place where it was at the commencement of the run, notwithstanding that, during the first half of the revolution, the star moved uniformly from this normal position, and during the second half moved back, through the same space, to its original place. In this way we have an automatic ceaseless to-and-fro motion of the star in the slit, quite uniform in both directions, and therefore giving an uniform exposure to the photograph throughout the breadth of the spectrum.

Of course, it is a matter for calculation in the case of each telespectroscope as to the most suitable ratio between the number of teeth on the two halves of the wheel.

With such a wheel the breadth of the spectrum will, indeed, vary with the star's declination; but by making this breadth a little greater than is absolutely necessary for stars of no declination, the breadth remains sufficient for a large range of declination. Any difficulty from this cause might easily be met by having two or three transferable wheels with different teeth-ratios.

Stellar Spectra on the Photographic Plate •

The advantages of this automatic mechanical arrangement are great, for not only will the personal fatigue of the observer be greatly lessened, but, what is of no little importance in a variable climate, the necessary time of exposure will be reduced, for every moment of the exposure will tell upon the plate, since there will come in no interruptions of photographic action, through any want of immediate and accurate bringing back of the star at the end of each run, as can scarcely fail to be the case when it has to be done by hand.