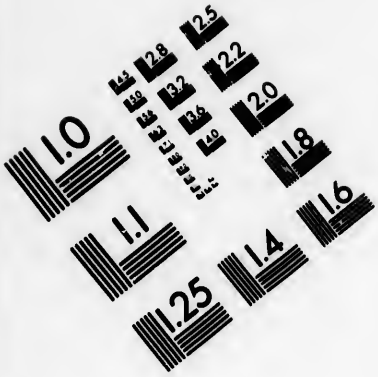

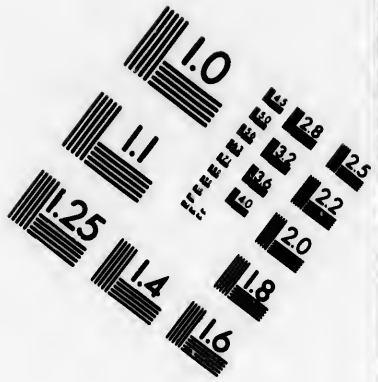

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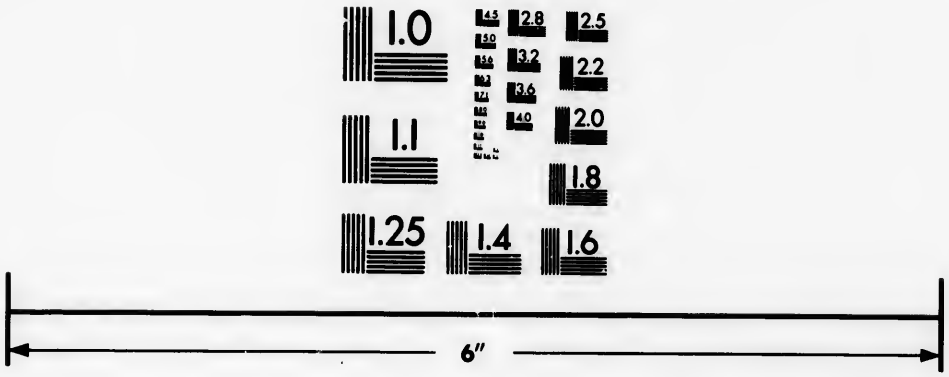

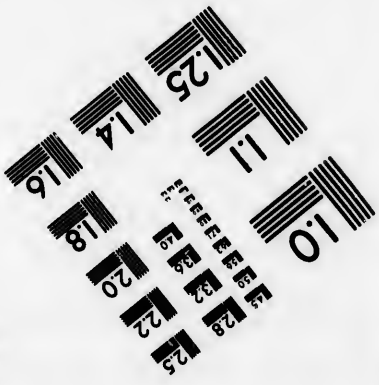

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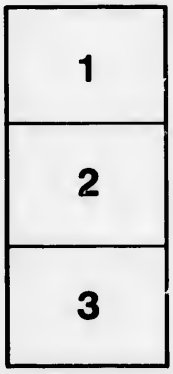

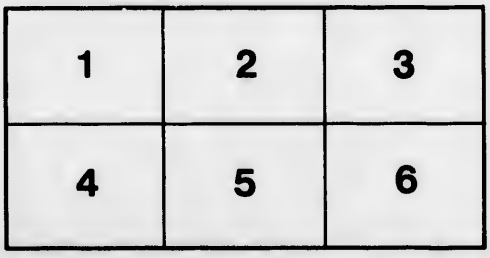

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32X

PARLOUR LESSONS

ON

THE STUDY OF THE STARS

AND CONSTELLATIONS

WITH THE USE OF A NEW 18-INCH ASTRONOMICALLY ARRANGED SPHERE,

BY

M. TURNBULL, S. B. I. L. Eng.,

AN ASTRONOMICAL TELESCOPIC OBSERVER OF TORONTO, ONTARIO.

1892.

"All obsolete things may become new under the reviving touch of genius."

—*Sidney Smith.*

TORONTO:

PRINTED BY WARWICK & SONS, 68 AND 70 FRONT STREET WEST.

1893.

A Circular explanatory of a new patented astronomically arranged sidereal sphere, to acquire a knowledge of the Stars and Constellations ; for use in Educational Institutions and Private Libraries, including the various precepts which are applied to interpret the doctrines of the Sidereal Heavens.

BY

MR. TURNBULL,

An Astronomical Telescopic Observer,

Of Toronto, Ontario.

November, 1892.

All obsolete things may become new, under the reviving touch of genius.—Sidney Smith.

PREFACE.

One of the principal objects the author has in view in this design is to make it possible to place on the floor of the domestic parlour, or an Academy, an illustrative mechanical apparatus which will serve all the important purposes to the private student of the stars that are served in every astronomical observatory, by the use of that beautiful instrument styled "*The Fraunhofer* (or German arranged) *Equatorial Telescope.*"* The only difference in the case being that the new invention, as it needs not, has not any of the optical lenses and appendages the other has to magnify the numerous objects examined on the model map of the Celestial Sky.

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*In the progress of optical research to improve the astronomical telescope, after Dolland, in England, made his great discovery of the process to perfect the instrument, it was a considerable time after before one could be made of sufficient magnitude to advance and widen the boundary of our knowledge of the Heavens. In Germany, Fraunhofer, an eminent Optician of Munich in Bavaria, and the inventor of Spectrum Analysis, was the first to overcome the difficulties which were in the way. He completed the first great Achromatic Equatorial mounted telescope, as above alluded to, which was bought by the Russian Government for the National Observatory at Dorpat, in latitude 57°, 22′, 47″. In astronomy the connection of this instrument with the observational labours of the late two distinguished, Struves and Argelander, and Bessal, especially the latter observer, who wrought with the instrument for thirty years to solve the parallax of 61 Cygnus, stamps it to be one of the foremost telescopes as yet used in the history of observational astronomy.

In explaining the subject matter of this circular it may be mentioned at the outset that a conspicuous feature of the design is the total abandonment of all the former methods, of teaching the constellations by rotating within a circle the entire cluster of the universe of stars. Those methods, as is now universally known, had their origin in the early absurd *Ptolemaic* theory or system of the universe, which was exploded centuries ago by the application of geometrical appliances in observational work.

The present apparatus on the other hand is founded upon the *Copernican* system of the universe, and is closely in unison with all the dynamical doctrines of modern astronomy, and the daily celestial experiences of the passing hour. In fact, the plan adopted is a true copy of the great original itself.

In that plan the sphere with all the stars remains completely *stationary* and *immovable* before the eye of the observer. Although, if required, while not solving problems on the position of objects on the Sphere, all the cluster of the stars can be revolved on the axis of the Sphere, which always retains its axial angle and parallelism with the orbit of the earth. But it has to be particularly noted that no single Celestial problem can be accurately solved, or any true likeness traced between the aspect of the model hemisphere of the stars, and the true appearance of the sky on any night, while the *Sphere* and its axis *revolve*. To secure, therefore, all the altered conditions made necessary by the new mechanical arrangements of the Sphere, the following plain structural details must be closely attended to, as follows:—Bring the two brilliant stars Alpheratz and Chaph, or better known in astronomy by Gamma *Andromeda* and Beta *Cassiopeia*, right below the annual Sidereal meridian, placed at the 20t.. of March, in the calendar of days in any year selected, and make the axis fast with the stationary screw, then the operator has clearly before him a true projection of all the hemispherical

constellations and stars as they exist to the eye on any evening, and are found in every modern catalogue and collection of maps of the stars in the passing age.

NEXT.—In describing the different mechanical appendages which form the structure of this celestial instrument it has to be particularly observed there are four distinct mechanical factors employed in its use, namely :—First. A semicircle placed from pole to pole of the sphere. It is meant to exhibit an outer sidereal solar meridian that moves annually in the ecliptic circle of the sphere, and carries at the same time the sun's supposed centre, which points off on the calendar of days all the right ascensions of our great luminary. This is an important arrangement as it serves the same purpose in the private parlour study of astronomy that the right ascension circle does, which is attached to the axis of the equatorial mounted telescope placed in all the public observatories.

SECOND.—Exhibits another meridian which revolves below and within the first just allu[illegible] to. It is introduced to rotate round the Sphere every twe[illegible]-four hours, representing the *axial rotation of the earth* and any place selected upon it. This part forms geometrically the great *exhibit* of the entire *terrestrial topography*, and is graduated on both sides from the equator up to the poles of the earth.

It may be mentioned here, to a juvenile observer of the stars, that as every place on the earth's rotundity is correctly determined by its latitude and longitude; those two important elements are correctly obtained from the foregoing structure and place of the terrestrial meridian. Its graduations give readily the *latitude* from both the terrestrial poles, and its position as traced by the index on the twenty-four hour-circle determines the *longitude* of the place where the observer is standing with the hour circle, the longitude can be determined to 10 seconds of arc.

THIRD.—Is an eight *hour-circle* graduated into hours, minutes and seconds of horary time? It is placed upon the southern axis of the Sphere, and is attached to and revolves like the celestial meridian round the heavens only once every year. Each day the two meridians coincide at noon, and that place is marked upon the hour-circle. Hence it will be observed as the celestial meridian advances in the ecliptic plane only about one degree in twenty-four hours, the two must separate continually during a day of axial rotation of the earth at the rate of 15° for every hour, and thereby converting the terrestrial meridian into a correct interpreter of the places of all those stars which it passes over on the Sphere and is above the observer's horizon at all hours, whether they are in the direct sunlight or in the opposite hemisphere of midnight darkness.

FOURTH.—This appendage constitutes a *quadrant of altitude* graduated to 90° and its place and function is to be screwed fast to the terrestial meridian, and to move round the zenith at the latitude of the place of observation, thus securing the means to find out the zenith distance of any star, and its true altitude above the horizon of the place. The use of this part of the apparatus is *extremely important*, as it introduces the system of solving many of the higher questions in celestial science, by the strict doctrines of geometry, instead of using the former mechanical plan of shifting circles, which has greatly the tendency to confuse an amateur in his higher studies. Another useful property which this part of the apparatus has, it enables an observer to accomplish the solution of all the altitudes of those stars which are above his horizon, rendering this instrument equivalent to what is obtained by the *Fraunhofer Telescope* formerly alluded to, and adding to the value of this method of mounting in the parlour study of the heavens.

Having assigned in a great measure the foregoing paragraphs to explain the physical structure of the two instruments we will endeavour in what follows shortly to apply them in a practical way to those things described in reference to their adaptation to simplify and extend the domain of two of the noblest of all the physical sciences. At this place of the subject we may note particularly that the first step to be taken by the amateur is to endeavour to discover clearly and thoroughly all the changed characteristics which surround this model of the universe of stars, especially viewed from a standpoint situate on the convex surface of the stationary sphere.

In the solution of those problems we purpose now to solve, we intend to follow the *seasonal* or *cyclic* order of the apparent shifting of the stars on the face of the sky. By this plan it will be observed, it divides the entire convex aspect of the whole sphere, so that by a seasonal examination there is a great advantage gained over work performed with any of those *sectional maps* published in *geographies* and *atlases* on the subject. Here, at the time of observation, the student has the whole visible hemisphere of the heavens at once distinct before his eye and all in the true position of the stars from the observer, and from each other. And in addition, in the operation the student is trained by the use of the mechanical details of the instrument to read correctly on the sphere all the places of the stars by the unerring rules of *geometry*, and the guidance of *graduated circles* which forms a training (as formerly mentioned) in the astronomical process, similar to what is gone through in the public observatory by the use of the forementioned *equatorial telescope*; hence the parlor use of this model of the starry sphere becomes a pleasant intellectual occupation, in acquiring a knowledge of the starry heavens.

In selecting a hemisphere to solve some problems on the stars on purpose to help a tyro to handle the apparatus, we propose to fix that period in the *seasonal year* when the sun's

centre is in the winter *solstice* about the 21st December. At this annual period at night, as we all know the richest and the most conspicuous of the northern constellations are visible, although through cold the most trying season to the observer. In particular at this time, we can select problems from *Gemini*, *Aruga*, *Perseus*, *Aries*, *Taurus*, *Andromeda*, *Cassiopea*, *Pegasus* and the glorious *Orion*, which in itself is a telescopic cloud of *universes*.

It may be mentioned in this place that all the annexed problems have been directly solved by the use of this newly arranged sidereal sphere, however it will be understood the renderings are all only *approximate*.

PROBLEM I.

To find upon the Map of the new arranged Sidereal Sphere the right ascension and declination of any star, planet, nebula, or comet?

RULE.—Bring always the Sidereal meridian over Alpha, Andromeda, at the 20th of March in the calendar of days. Then shift on the hour circle the index attached to the terrestrial meridian to the hour, minutes and seconds of right ascension given and the place of the terrestrial meridian on the Sphere will indicate the plane in which the object is placed; next, to find the arc of declination, screw the quadrant of altitude on the graduated meridian at the ecliptic plane when the arc of declination can be found to lead the eye to the precise place where the phenomenon is situated.

PROBLEM II.

What is the position on the sky of the brilliant nautical star *Regulus*, its zenith and distance from meridian at the city of New York on February 4th, at 9h. 15m. p.m.?

RULE.—Bring the sun's centre on the ecliptic plane to the day named, February 4th. Next place the index on the hour circle at the time given, 9h. 15m. Then screw the quadrant of altitude at th latitude of New York 40° 42′, and bring it over the star, when its zenith distance and altitude will be found.

(It may be noted here that with the new arranged sphere, the altitude of any star is obtained by subtracting the zenith arc from 90°.)

Again to find the place of *Regulus* from the meridian at the time named, move the terrestrial meridian from its place at February 4th till it is over *Regulus*; when the arc in degrees and minutes will be found on the hour circle.

ANSWER.—The distance of *Regulus* from the zenith of New York, at the time noted was 50° 12' with an altitude above horizon of 39° 48', and its distance from the meridian was 30° 12′ west.

PROBLEM III.

In what time in the twenty-four hours does the *Double-double* in the constellation *Lyra*, pass the meridian of Chicago, and what is its zenith distance and altitude above horizon, and when does it rise and set on the 14th of July?

RULE.—Place the sun's centre at the day given, July 14th. then screw the quadrant of altitude at the latitude of the city 41° 53′, and bring the terrestrial meridian over the object named, when its zenith distance and altitude will be given, Next to solve when the Double-double rose and set, bring the quadrant till its end just touches the object on the sphere, when the index on the hour circle will show the time at rising. Then move the terrestrial meridian east and the index circle will again point to the time when it set.

ANSWER.—The *Double-double* was on the meridian of Chicago at 11h. 20m. p.m., and the zenith arc was nearly 2°, with an altitude of 88°, and it rose at 2h. 20m., p.m. and set next morning at 7h. 58m. a.m.

PROBLEM IV,

Where on the sphere is the great *Nebula* of *Orion*, and what is its zenith distance and altitude, and when did it rise and set to the city of Boston, on January 20th at 1h. 16m. a.m.?

RULE.--Bring the sun to the day named, January 20th, then screw the quadrant of altitude to the latitude of Boston, 42° 21′, then move the index on the hour circle to 1h. 16m. a.m., which will give the zenith arc and altitude; again to find when the Nebula rose and set, move the terrestrial meridian west till it brings the end of the quadrant to touch the object on the sphere, and the degree shown by the hour index is the time when it rose. And to find when it set, move the terrestrial meridian east till the quadrants end touch again the object, and the degree pointed to gives the time when it set.

ANSWER.—The zenith distance of the *Nebula* at the hour named was 37° with an altitude of 53° above horizon, and it rose at 4 p.m. and set at 3h. 16m. next morning.

PROBLEM V.

In what ecliptic constellation is the sun on the 21st December, and what is the arc of distance between the zenith of Toronto, in Ontario, and *Alpha Andromeda*, with its altitude above the horizon at 10h. 30m. p.m.?

RULE.—Bring first the sidereal meridian to the day named, December 21st, then place the terrestrial meridian at the hour given, 10h. 30m., next screw the quadrant on the meridian of Toronto at the latitude of the city, 43° 40′. Bring the quadrant over the star named when the zenith arc will be

found, which being subtracted from 90° will give the altitude above horizon at the hour required.

ANSWER.—The sun is in the southern solsticial colure in the beginning of *Sagittarius*, and the distance of *Andromeda* from the zenith of Toronto was 51° with an altitude of 39° above horizon.

PROBLEM VI.

What is the position on the sphere of that beautiful double star *Beta Cygnus* (Alberio), in reference to its zenith arc, and altitude from horizon, likewise its distance from the meridian as seen at Philadelphia High School Observatory on June the 25th, at 9h. 8m. p.m., also when did the star rise and set at the time given?

RULE.—Place the sun in the ecliptic plane at the day June 25th, next screw quadrant over Philadelphia, latitude 39° 58′, then place the quadrant over the star and note the degree. The degree points out on quadrant the zenith arc at the time; subtract the arc found from 90° and the altitude is given. To find when *Alberio* rose and set to Philadelphia move the terrestrial meridian *west* till the quadrants *end* just touches the star; the index on the hour circle shows when it rose; and by moving the meridian and quadrant *east* till the quadrants end again touches the stars and the index place will solve when it *set.*

ANSWER.—The zenith arc of Alberio at 9h. 8m. p.m., was 51° 30′, and its altitude above horizon 38° 30′, and the star rose that day at 5h. 20m. p.m. and it set at 9h. 12m. a.m. next morning. Also the arc of Alberio at 9h. 8m. p.m. was 60° 8′ east from meridian of the School Observatory.

PROBLEM VII.

In this problem we purpose to suppose that the eminent Director, Dr. Swift, of the Warner Observatory, Rochester, had discovered a new telescopic comet (as he has often done before) on the night of the 10th September last, and found it moving west in right ascension 19 hours 20 minutes with a declination of 41° 10′.

Now, from those figures, in what constellation will the comet be moving, and what are the names of the visible stars near the place where the phenomenon is situate on the sphere ?

RULE.—Bring first the index on the hour circle to the right ascension named at the time of discovery on September 10th, at 9h. p.m. Then afterwards note on the graduated meridian the degree of declination 41° 10′, when the two elements will be forthcoming to solve the question.

ANSWER.—From the above directions the comet, as seen geocentrically from the earth, is moving through the constellation *Cygnus*, near the star Gamma, and being moving west its orbit on the sphere will pass between Beta and Alpha, *Lyra* (Vega), near the ring nebula in that constellation.

PROBLEM VIII.

This problem is selected to illustrate the use of this instrument in an important branch of the observations made during a total eclipse of the sun's disc.

On the 15th and 16th of April, 1893, one of the greatest eclipses of the sun in this century takes place. The umbra or zone of totality, which is nearly 180 miles broad, during its motion

over the earth passes through the centre of South America, chiefly over the Argentine Republic, the Pacific Ocean, and a large part of South Africa. Now, as all places at the centre of the zone of totality on this occasion have a complete obscuration of the sun for about five minutes of time, and as all stars of the first and second magnitude become visible to the unassisted eye round the sun, how many will be discovered at the time, with their distances from the sun on the sphere, and what are their names as read by the Greek alphabet (Bayer's notation)?

RULE.—Bring the sun and moon in the Zodiac to their right ascensions at the middle of the eclipse, viz.: 1h. 39m. 28s. Their centres are then both cutting the axis of ecliptic. Next screw the sector of altitude at the sun's place in the ecliptic plane and the different phenomena above mentioned can be all solved on the starry hemisphere.

ANSWER.—Four of the first stars which will attract the naked eye near the sun will be the square of *Pegasus*, especially the northern one, Alpha *Andromeda* (Alpheratz). Its distance from the sun is north-west about 32° and *Algenib* orgamme pegasus, its neighbour, is only 15° due east from the sun. *Aldebaran* will also appear very distinctly at a distance of about 43° from the eclipse, and *Capella*, a little higher north-east from the sun, will be shining prominent at a distance of 60°. Also not far west from *Capella*, Alpha *Persei* (Mirfak) will be observed 48° from the sun, and Alpha *Arietes* (the equinox of the ancients), being only 16° distant from the sun, will be readily observed. At the same time all the first and second magnitude stars in the brilliant constellation *Orion*, far south-east, will be seen. *Belatrix* is 63° from the eclipse and *Rigel* 68°. Also all the four stars of the second magnitude in *Cassiopeia* will be picked up. They are due north near meridian and placed between 48° and 52° from sun. It may be

added here as observers have seldom such an opportunity as this to make research for the long spoken of planet *Vulcan* surely this chance will not be lost sight of to settle this interesting unsolved problem.

PROBLEM IX.

To the inhabitants of the southern hemisphere during the southern summer months, all their stars and constellations are nearly invisible; however, after the sun has crossed the equinoctial circle in March, when their nights begin rapidly to *lengthen*, then the southern stars begin to shine out in all their alluring glory. Now, during the best time of their starry season, what are the most conspicuous constellations visible with some of the principal stars in each, and how are they situate on the sphere as seen from the late Sir Thos. Brisbane's Paramatta Observatory,* near Sydney, New South Wales, in latitude 33° 49′ and at 1h. 12m. a.m. on the 10th June?

RULE.—Bring the sun in the ecliptic circle to the day named in the calendar, June 10th, then move the terrestrial meridian with its index on the hour circle to the time stated 1h. 12m. a.m.

The meridian then on the sphere is over the Paramatta Observatory. Next screw the graduated sector to the latitude of the place 33° 49′, when everything involved in the above question can be readily solved in reference both to the extent of the zenith arc or the altitude of a star, and its distance from the meridian of the place.

ANSWER.—Among the most noted constellations which may be first alluded to in the southern winter are those which belong to the Zodiac, namely, *Aquarius*, *Sagittarius* and *Scor-*

*This observatory was the first to scan the southern constellations by the modern methods now adopted in astronomy.

pionis. At the time given above Alpha *Scorpio* (Antares) is 46° from the zenith of Paramatta and Delta (Deneb) *Capricorni*, its zenith distance is 21°. In *Aquarii*, Alpha (Sadalmelik) on the right shoulder of the *Sine* is north-east about 15° with an altitude above horizon of about 45°.

At this season the beautiful constellation *Corona Australis* is nearly in the zenith of Sydney, only distant about 10°, and closer up and east towards the south pole Alpha in *Indus* is a brilliant object about 31° from the zenith. Again, the three second magnitude stars, Beta, Gamma and Eta, in the three angles of *Triangulum Australe* are very conspicuous objects, and are all within the Antarctic circle. At the same hour Alpha, Beta and Gamma in the constellation *Lepus* are prominent stars ranging between 25° and 38° from the zenith of Sydney. Perhaps it is worth stating that during the southern winter months there are only about four first magnitude stars of the northern hemisphere which are seen from a great portion of Southern Australia, Tasmania and Van Diemen's Land. *Arcturus*, *Lyra* and *Altair* will be the most conspicuous.

Altair from the zenith of Paramatta is always in fine position, 48° only from the horizon, but *Arcturus* and *Lyra* and Alpha *Cygnus*, will be seen only in very fine evenings.

Close attention paid to the methods given of solving the above problems, with a little practice at the present mechanical system as applied to the sphere of the stars, will readily *initiate* any juvenile observer with the telescope into a clear knowledge of all the numerous objects found everywhere on the face of the sky. And, moreover, the apparatus with its training enables the celestial investigator at all hours, independent of the weather, to handle the model sphere as it is operated upon with the equatorial in any observatory.

FINIS.