He has succeeded, however, in obtaining prisms of this material whereby to investigate the subject of the molecular vibrations associated with wave lengths.

Sir Isaac Newton determined wave lengths of 0·00003 to 0·00007 millimeter. In 1882, all that was certain was wave lengths of 0·00010 m.; within two years we went down to 0·00027 m. There we found that the sun's effect ceased.

Much greater results were subsequently obtained by the use of Rowland's gratings, being made of extraordinary size for this purpose. The apparatus was described in detail. It was of such delicacy that readings could be made down to 0·1 m. when there was one vibration in 40 seconds. The sodium lines were taken as fixed points of comparison.

The difficulty of manipulation was indicated by the statement that the spectrum to be examined must be identified and distinguished from among twenty or more other visible and an almost infinite number of invisible spectra.

The delicacy of the apparatus employed was such that the presence of a current of only 0 000000001 ampere was distinguishable.

Two years of work were required to overcome difficulties. The extrapolation formulæ employed led to cubic equations difficult to solve.

By means of numerous experiments, however, it was ascertained that the relation of the index of refraction to the molecular wave length of vibration throughout the entire spectrum is nearly represented by a hyperbola.

As a result, the shortest wave length measured was about 53,000 on Angstrom's scale. The longest wave length of the visible spectrum is about 0·01 m. The extremes found by Langley were 0·1 m. and 0·0025 m.

The shortest wave length of sound determined by Helmholtz is about 5 m., being only fifty times the length of Langley's longest wave length of the spectrum, thus vastly reducing the hitherto immeasurable gulf between light and heat on one hand and sound on the other.

Professor H. A. Newton read an important paper on Biela's comet, which is connected with the November meteoric shower. This shower was mostly over before sunset in this country, but in Europe it was notably brilliant, exceeding the display of 1872, though not equal to that of 1833.

In many places, up to a hundred a minute were counted by a single person, the maximum display continuing not more than three hours. Experiments show that no single observer can detect more than one-eighth of the entire number that fall; so that the shower probably amounted to 75,000 per hour.

To compute the density of their distribution in space, we must take into account the fact that we do not see them near the horizon as we should if we saw all that fall. One in fifty of all that are visible come within 10° of the zenith.

Computing the path of the earth through its orbit for three hours, it appears that the dense shower only occupies a space 87,000 miles in width, hence each meter corresponds to an area 20½ miles square.

Applying proper correction for the effect of the earth's attraction, the dispersion of meteors covered about 10°; although, as seen from the sun, the apparent thickness of the shower belt is only 4′, and its actual thickness therefore is only 8′.

If these meteors come to us though a range of 10°, they represent, not a group, but a wide dispersion through space. The only possible explanation of the wide divergence, therefore, is that they glance when they strike the earth's atmosphere.

This explanation, it is true, has been previously suggested, but it has seemed to be untenable, for the reason that the meteors as we see them always move in straight lines. An ingenious explanation of this was now given. The meteors are small irregular bodies, which, when they strike the atmosphere, are cold and dark, and compress the air before them to such an extent as to compel them to change their course to a path of less resistance; but as soon as the pressure and friction heat them to incandescence, the side which is forward fuses, and is wiped off by the impact of the air, leaving the glowing particles behind, which constitute the trail, and at the same time rounding off the front of the meteor, so that it will thereafter proceed in a straightforward course, like a round bullet, having no longer the sharp angles which at first compelled it to glance. Thus it is that the meteors are dispersed while dark and invisible; but as soon as they become visible, they have assumed the rounded form, which gives them a straight path from the time when we are first able to discern them. Were it not for this dispersion, we might fix the direction of the radiant within an angular distance only one-quarter the apparent diameter of the full moon, and the shower would be seen pouring down in this narrow stream. The radiant last November was in zenith nearly over the Black Sea.

In 1841, Biela's comet came near to Jupiter, and its course was changed. It was at the same time broken into two large and innumerable small fragments.

Comparing the longitude of the meteoric showers before this disruption with that of Biela's comet, a substantial conformity is seen. Afterward, both comet and meteors underwent a radical change of longitude, and still the new position in longitude was the same for both comet and meteors. Comparison of right ascension also gives the same results.

This proves conclusively that the meteors were not separated from the comet until after its disruption, and it follows as a corollary that the disintegration of the comet is in progress, and that it will be ultimately dissipated; which is further apparent from the fact that the comet was not visible at the computed periods of the return in 1859 and 1866. We are now one hundred million miles distant from where the comet ought to be.

The meteoric showers will also gradually become less conspicuous, on the whole, although the earth may occasionally, as last November, pass through a denser portion.

The prominence given at this meeting to astronomy and astronomical physics by the award of the Draper medal seemed to entitle these papers to precedence, leaving till next week the report of Hunt's paper on the Cowles electrical furnace, and its immense practical value in the metallurgy of aluminum and other metals.

Prof. Wolcott Gibbs was elected Foreign Secretary in place of Alexander Agassiz, resigned. W. H. H.

## NIGHT SKY—APRIL AND MAY.

BY RICHARD A. PROCTOR.

The Great Bear, *Ursa Major*, is now at its highest and nearly overhead, the pointers aiming downward from high up, slightly west of due north. A line from the Pole Star, $\alpha$ of the Little Bear, *Ursa Minor*, to the Guardians of the Pole, $\beta$ and $\gamma$, is now in the position of the minute hand of a clock eight minutes after an hour.

Below the Little Bear we find Cepheus low down to the east of north, and *Cassiopeia* low down to the west of north. *Perseus*, the Rescuer, is setting in the northwest; the Camelopard is above, trying to get on his feet.

The Charioteer, *Auriga*, with the bright Capella is nearing the northwestern horizon, followed by the Twins, *Gemini*, in the west. Further west and higher we find the Crab, *Cancer*, below which is the Little Dog, *Canis Minor*.

The southwestern sky is very barren of bright stars, *Alfard*, the heart of the Sea Serpent, *Hydra*, shining alone in a great blank space. Above the Sea Serpent's head we see the Sickle in the Lion, *Leo*, himself stretching his tail to due south, very high up. *Coma Berenices* is close by, and the Hunting Dogs, *Canes Venatici*, between Coma and the Great Bear.

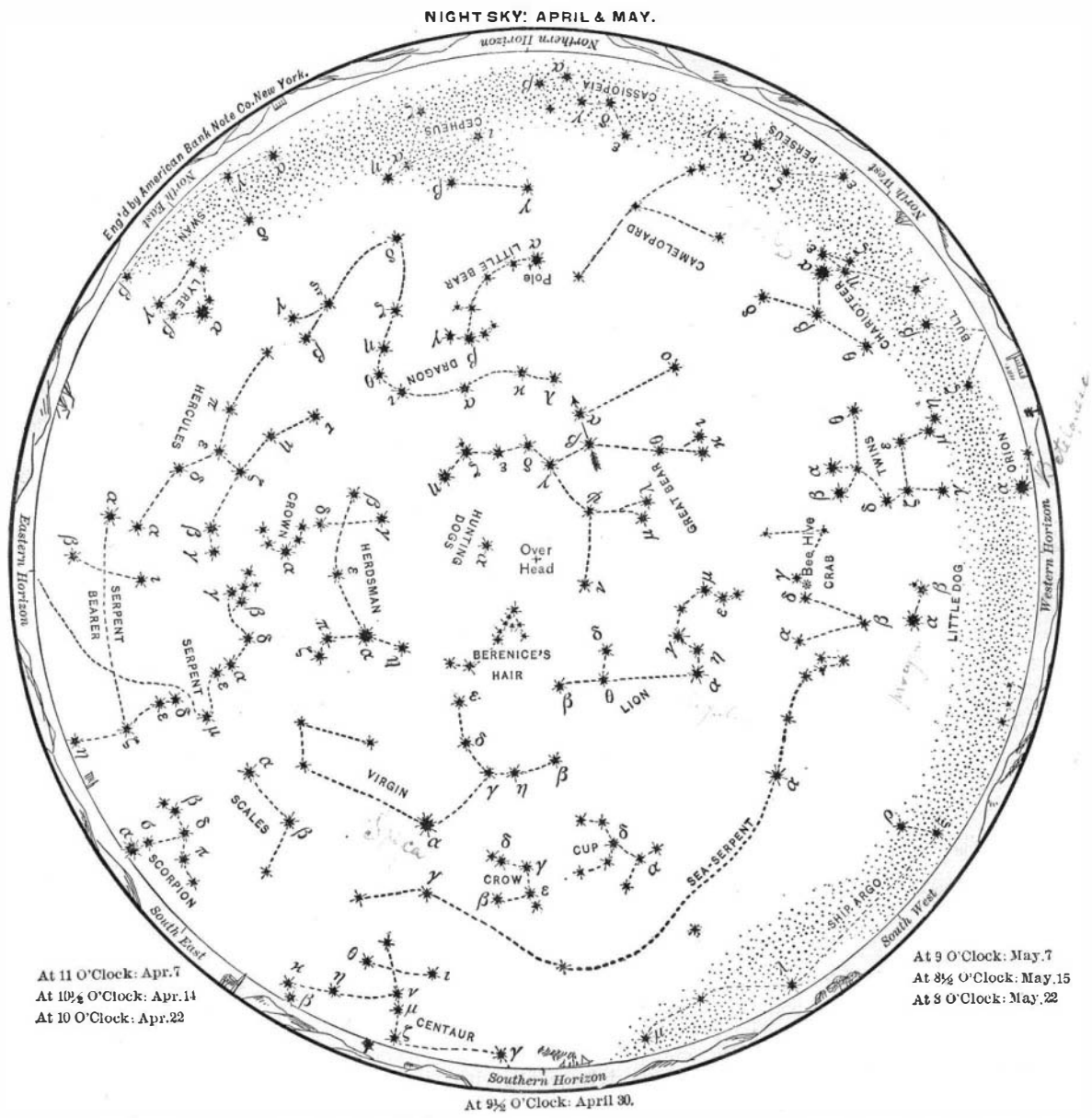
In the south, lower down, we find the Crow, *Corvus*, and the Cup, *Crater*, on the Serpent's back; the Virgin, *Virgo*, extending in the mid-heavens from southeast to south, between the Lion's tail and the Crow. In the same direction, but low down, we find the head and body of the Centaur, *Centaurus*, supposed to have typified the patriarchal Noah.

In the southeast the Scorpion's Heart has just risen, and between the head of *Scorpio* and the Virgin's robes we see the stars of the Scales, *Libra*.

Due east, low down, is the Serpent Holder, *Ophiuchus*, on his back—'tis the customary attitude of heavenly bodies when rising. The Serpent, *Serpens*, held by him is seen curving upward toward the Crown, *Corona Borealis*. The Serpent's head is due west, and above it we see the bright Arcturus, chief brilliant of the Herdsman, *Bootes*.

In the northeast is *Hercules*, his head close to the head of the Serpent Holder. Beneath his feet is the Lyre, *Lyra*, with the brilliant Vega; and the Swan, *Cygnus*, has already half risen above the northeastern horizon.

Lastly, the Dragon, *Draco*, curves from between the pointers and the pole, round the Guardians toward Cepheus, and then retorts its head, with gleaming eyes ($\beta$ and $\gamma$), toward the heel of Hercules.




In the map, stars of the first magnitude are eight-pointed; second magnitude, six-pointed; third magnitude, five-pointed; fourth magnitude (a few), four-pointed; fifth magnitude (very few), three-pointed; counting the points only as shown in the solid outline, without the intermediate lines signifying star rays.

### Magnetic Qualities of Iron.

It is well known what an influence the quality of the iron in the field magnets has upon the ultimate output in a dynamo, and a case in point is mentioned by Mr. Gisbert Kapp, showing how impossible it is to foretell accurately the performance of a dynamo unless the quality of the iron be exactly the same in the manufactured machine as the sample submitted. In the case of two machines manufactured for him, there was a difference of electro-motive force of 20 per cent between the two, although the machines were of exactly the same dimensions and treated in the same manner. It was imagined that in the first machine the iron magnets had not been sufficiently annealed, in consequence of the shortness of time allowed for the work. A second pair of field magnets were ordered and an extra time allowed for the work, the consequence being that 20 per cent. more electro-motive force was obtained.

### Erratum.

In Abernethy's keying clamp, illustrated on page 242, April 17, 1886, the slots shown in the cut should not extend entirely through the jaws, as represented. They should be about half the depth of the jaws.