comparison with the hydrogen line 1215.68 and with the three following lines of the same series is therefore possible, with the result that the wave-lengths are probably correct to one or two tenths of a unit.

The spacing of these four helium lines on the frequency scale is of great interest and importance, for it is found to be identical with the spacing of the first four lines in the singlet principal series. It may be stated therefore with considerable certainty that the line 584 forms the first member of a principal series, which, according to the notation of Professor Fowler, is to be represented by oS-mP.

Besides this series there is a single line at $600.5 \pm .3$ of a feeble and diffuse character; its origin is not entirely above suspicion. In the extreme ultra-violet the arc spectrum of helium appears to contain no lines in addition to those just mentioned.

The relation between the accepted values of the resonance and ionization potentials in helium and the wave-lengths of these new lines is rather puzzling. The ionization potential should certainly correspond to the limit of the oS-mP series; now this limit can be accurately calculated, it corresponds to 24.5 volts but the experimental value is 25.3 volts. This is the chief difficulty, but it is not the only one, for the agreement between the wave-lengths of the individual spectrum lines and the values of the resonance potentials as determined by Franck and Knipping is not satisfactory. A correction of about —0.8 volts if applied to all the potential measurements will bring the two sets of data into fair agreement but at the expense of the first resonance potential which is left without any corresponding line in the spectrum.

The matter should be of some interest to those who are struggling with the model of the helium atom.

Theodore Lyman

Jefferson Laboratory,
Harvard University,
August 3, 1922

THE CALIFORNIA POPPY

It is perhaps strange that students of genetics have not given more attention to the plant which is the glory of California fields, the Copa d'Oro or California poppy, *Eschscholtzia californica* chamiso. It is a plant easily raised from the seed, remarkably affected by external conditions as well as subject to marked variations, fluctuations or mutations, which could be readily confirmed or intensified by selective breeding.

So great is the variability of this plant that Greene has separated the ordinary perennial form into thirty-two different "species," while of the eight or nine other forms, annuals, closely related to the golden poppy, but tangibly distinct from it and from each other he defines seventy-three species with some outlying varieties. To this incredible list, Fedde, a German botanist, adds several more. There is in fact no limit if we regard every peculiar plant as the type of a new species, without evidence as to the origin and permanence of its variation. Such a condition, as observed by Darwin among cirripeds, is attractive to us "as speculatists, however odious to us as systematists."

The flowers of *Eschscholtzia californica* are normally of a deep, rich orange, the four petals with entire edges an inch and a half long. Near the seashore the flowers are smaller, of a more or less clear lemon yellow, orange at base or not. This is apparently "ontogenetic" variation, not entitled to a systematic name, because likely to disappear with a changed environment, as the plant is not only inherently variable but responds directly to all changes of soil and season.

Towards the end of a rainless summer, the upright flower stalks wither and flowers successively smaller spring from near the rootstock. These are of a clear lemon yellow, sometimes more or less orange at base, the orange fading as the flower grows smaller.

Just now looking from my window as I write over a field golden with blossoms, I see numerous variations, some of them perhaps to be called mutations, as they are quite striking and, occurring in patches must be more or less permanent. In several areas the flowers are of a light creamy yellow, the petals holding their place when plucked longer than in the orange form. Another group has large flowers of a citron color. On some plants the petals are more or less laciniate on the margin. Frequently they are five in number, sometimes six, often eight. The number of pistils is not fixed, and the bifid cotyledon and broad rim of the torus, both traits normally characterizing the true *californica* (the smooth perennial), are often as elusive as the other characters.

The color especially lends itself to modification by selection. Burbank once found a plant with a crimson streak like a red thread at the base of each petal. Saving the seed, he obtained through selection alone a poppy with the flowers all crimson. Seedlings from Burbank sometimes have pinkish flowers, almost white.

Eschscholtzia has certain advantages over the evening primrose for experimental purposes. It is a natural species occurring by the million in its habitat. Though very difficult to transplant, it grows readily from the seed. It is therefore not a garden variant, nor a suspected hybrid. *Œnothera lamarckiana,* thus far the subject of most mutation experiments, though cultivated in Europe, is American in origin. No one, I believe, has yet ever found it growing wild anywhere.

In any event, accurate studies of the variation in *Eschscholtzia* should be interesting and repaying.

DAVID STARR JORDAN.

THE TEMPERATURES OF METEORITES

IN the last number of SCIENCE[1] Dr. George P. Merrill discusses some matters connected with meteorites. With regard to their temperature he says, "it seems certain that they have been wandering for an indefinite period in space and at a temperature of 'absolute zero.' At the time of entering our atmosphere it is fair to assume that they are cold throughout to a degree of which we can have no conception." It has seemed to me worth while to examine roughly what temperature a meteorite might reasonably be expected to have just before it enters the atmosphere of the earth. The meteorite has certainly been for some time exposed to radiation from the sun, and it may well be that its temperature is much higher than the absolute zero.

[1] SCIENCE, 55, p. 675, 1922.

To get some idea as to the temperature suppose that the meteorite is a sphere with a black surface, and that the material of which it is composed is a perfect conductor of heat. The temperature of this sphere is determined by the condition that the rate at which it loses heat by radiation equals the rate at which it receives heat from the sun. The condition is expressed by the equation

$$4\pi r^2 \sigma \theta^4 = \pi r^2 b \frac{e^2}{d^2}, \qquad (1)$$

where r stands for the radius of the meteorite, σ for the constant in the Stefan-Boltzmann radiation formula, θ for the absolute temperature of the meteorite, b for the solar constant, and e and d for the respective distances of the earth and the meteorite from the sun. If we take σ as $1.279 \cdot 10^{-12}$ cal./cm^2.sec.deg.^{4} and b as 1.93 cal./cm^2.min. (1) leads to

$$\theta = 282\sqrt{\frac{e}{d}}. \qquad (2)$$

Thus if black spheres which conduct heat perfectly were placed at the same distances from the sun as the several planets, (2) shows that the temperatures of these spheres would be the following:

At the distance of

Mercury	180° C.
Venus	58° C.
Earth	9° C.
Mars	—45° C.
Jupiter	—149° C.
Saturn	—182° C.
Uranus	—209° C.
Neptune	—221° C.

We see that in the neighborhood of the earth such a sphere would have a temperature above that of melting ice!

But a meteorite is not a perfect conductor of heat. Suppose we apply the above method of reasoning to a sphere which is a perfect non-conductor of heat, covered, except along a narrow equatorial line, by a thin layer of a substance which is a perfect conductor of heat and is black. The conducting layer forms two separate caps, and if one cap is turned toward the sun and the other away from the sun we