

of confirmation occupied a long period, during which it became more and more satisfactory and complete. In fact, so great has the coincidence of calculation with observation turned out to be, in all problems of physical astronomy, that no astronomer at the end of this century doubts that the gravitation formula alone will suffice to explain all anomalies which still exist in great number in the movements of cosmic bodies—such, for instance, as the moon.

40.
The Newtonian formula
the basis of
physical
astronomy.

Moreover, in the whole wide range of physical and chemical, not to speak of other natural phenomena, there is probably no instance of a simple mathematical relation having been applied to so large a field of facts, found so trustworthy a guide, and been so unfailingly verified.

And yet the very extent of this field must not blind us to the fact that for the explanation of molecular¹

¹ This is indeed not to be wondered at when we consider that in all molecular and molar phenomena such a variety of elements and forces come into play that it is impossible to isolate any special quantities as we do when from the cosmic point of view we lose sight of everything except mass, time, and distance—*i.e.*, the elementary factors of our system of measurement. In the phenomena of electricity, for instance, it is merely by a process of mental abstraction, which has no counterpart in the observable phenomena, that we speak of electrical masses, be they one or two; of fluids; of elements of currents, which in nature cannot exist alone; of velocities of a something which as yet cannot be clearly defined. Any mathematical formula can under such conditions be merely

tentative, and the preciseness of it must not hide from us the fact that it is based upon hypothetical relations and artificial definitions. This was, for the gain of scientific thought, very clearly brought out in the theoretical discussions which followed upon Helmholtz's critical examination of Weber's and kindred formulæ, and is well expressed by Carl Neumann: "Electrical matters"—if such there be—"never exists alone, but only in combination with ponderable matter." Any law like that of Weber can therefore be merely a "particular," not a "fundamental" or "universal" law, for it refers merely to a small portion of the properties, forces, and relations of electric and ponderable matter, leaving others—as, for instance, those between electricity and heat, electricity and light,