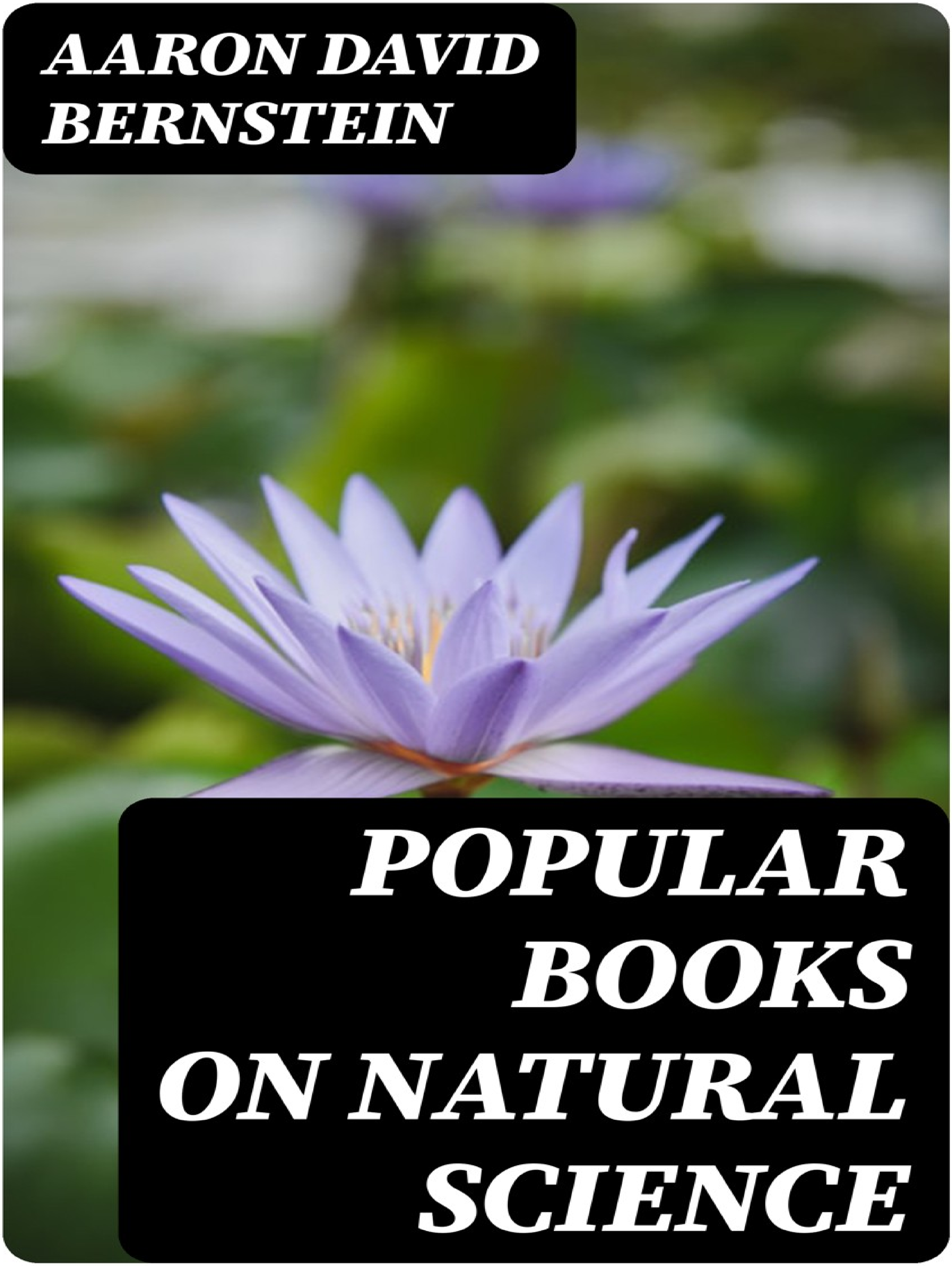

AARON DAVID BERNSTEIN

POPULAR BOOKS ON NATURAL SCIENCE

Aaron David Bernstein

Popular Books on Natural Science

For Practical Use in Every Household, for Readers of All Classes

EAN 8596547254751

DigiCat, 2022
Contact: DigiCat@okpublishing.info

DigiCat

Table of Contents

New York:
CHR. SCHMIDT, PUBLISHER, 39 CENTRE STREET.

BERNSTEIN'S

Table of Contents

POPULAR TREATISE

Table of Contents

ON

NATURAL SCIENCE.

Table of Contents

"In primis, hominis est propria VERI inquisitio atque investigatio. Itaque cum sumus negotiis necessariis, curisque vacui, tum avemus aliquid videre, audire, ac dicere, cognitionemque rerum, aut occultarum aut admirabilium, ad benè beatéque vivendum necessariam ducimus;—ex quo intelligitur, quod VERUM, simplex, sincerumqe sit, id esse naturæ hominis aptissimum. Huic veri videndi cupiditati adjuncta est appetitio quædam principatûs, ut nemini parere animus benè a naturâ, informatus velit, nisi præcipienti, aut docenti, aut utilitatis causâ justè et legitimè imperanti: ex quo animi magnitudo existit, et humanarum rerum contemtio."

CICERO, DE OFFICIIS, Lib. 1. § 13.

Before all other things, man is distinguished by his pursuit and investigation of TRUTH. And hence, when free from needful business and cares, we delight to see, to hear, and to communicate, and consider a knowledge of many admirable and abstruse things necessary to the good conduct and happiness of our lives: whence it is clear that whatsoever is TRUE, simple, and direct, the same is most congenial to our nature as men. Closely allied with this earnest longing to see and know the truth, is a kind of dignified and princely sentiment which forbids a mind, naturally well constituted, to submit its faculties to any but those who announce it in precept or in doctrine, or to yield obedience to any orders but such as are at once just, lawful, and founded on utility. From this source spring greatness of mind and contempt of worldly advantages and troubles.

PART I.

Table of Contents

THE WEIGHT OF THE EARTH.

Table of Contents

CHAPTER I.

Table of Contents

HOW MANY POUNDS THE WHOLE EARTH WEIGHS.

Natural philosophers have considered and investigated subjects that often appear to the unscientific man beyond the reach of human intelligence. Among these subjects may be reckoned the question, "How many pounds does the whole earth weigh?"

One would, indeed, believe that this is easy to answer. A person might assign almost any weight, and be perfectly certain that nobody would run after a scale, in order to examine, whether or not an ounce were wanting. Yet this question is by no means a joke, and the answer to it is by no means a guess; on the contrary, both are real scientific results. The question in itself is as important a one, as the answer, which we are able to give, is a correct one.

Knowing the size of our globe, one would think that there was no difficulty in determining its weight. To do this, it would be necessary only to make a little ball of earth that can be accurately weighed; then we could easily calculate how many times the earth is larger than this little ball; and by so doing, we might tell, at one's finger-ends, that—if we suppose the little earth-ball to weigh a hundred-weight—the whole globe, being so many times larger, must weigh so many hundred-weights.

Such a proceeding, however, would be very likely to mislead us. For all depends on the substance the little ball is made of. If made of loose earth, it will weigh little; if stones are taken with it, it will weigh more; while, if metals were put in, it would, according to the kind of metal you take, weigh still more.

If, then, we wish to determine the weight of our globe by the weight of that little ball, it is first necessary to know of what our globe consists; whether it contains stones, metals, or things entirely unknown; whether empty cavities, or whether, indeed, the whole earth is nothing but a hollow sphere, on the surface of which we live, and in whose inside there is possibly another world that might be reached by boring through the thick shell.

With the exercise of a little thought, it will readily be seen that the question, "How much does our earth weigh?" in reality directs us to the investigation of the character of the earth's contents; this, however, is a question of a scientific nature.

The problem was solved not very long ago. The result obtained was, that the earth weighs 6,069,094,272 billions of tons; that, as a general thing, it consists of a mass a little less heavy than iron; that towards the surface it contains lighter materials; that towards the centre they increase in density; and that, finally, the earth, though containing many cavities near the surface, is itself not a hollow globe.

The way and manner in which they were able to investigate this scientifically, we will attempt now to set forth as plainly and briefly as it can possibly be done.

CHAPTER II.

Table of Contents

THE ATTEMPT TO WEIGH THE EARTH.

It is our task to explain, by what means men have succeeded in weighing the earth, and thus become acquainted with the weight of its ingredients.

The means is simpler than might be thought at the moment. The execution, however, is more difficult than one would at first suppose.

Ever since the great discovery of the immortal Newton, it has been known that all celestial bodies attract one another, and that this attraction is the greater, the greater the attracting body is. Not only such celestial bodies as the sun, the earth, the moon, the planets, and the fixed stars, but *all* bodies have this power of attraction; and it increases in direct proportion to the increase of the mass of the body. In order to make this clear, let us illustrate it by an example. A pound of iron attracts a small body near by; two pounds of iron attract it precisely twice as much; in other words, the greater the weight of an object, the greater the power of attraction it exercises on the objects near by. Hence, if we know the attractive power of a body, we also know its weight. Nay, we would be able to do without scales of any kind in the world, if we were only able to measure accurately the attractive power of every object. This, however, is not possible; for the earth is so large a mass, and has consequently so great an attractive power, that it draws down to itself all objects which we may wish other bodies to attract. If, therefore, we wish to place a small ball in the neighborhood of ever so large an iron-ball, for the purpose of having the little one attracted by the large one, this little ball will, as soon as we let it go, fall to the earth, because the attractive power of the earth is many, very many times greater than that of the largest iron-ball; so much greater is it, that the attraction of the iron-ball is not even perceptible.

Physical science, however, has taught us to measure the earth's attractive power very accurately, and this by a very simple instrument, viz., a pendulum, such as is used in a clock standing against the wall. If a pendulum in a state of rest—in which it is nearest to the earth—is disturbed, it hastens back to this resting-point with a certain velocity. But because it is started and cannot stop without the application of force, it recedes from the earth on the other side. The earth's attraction in the meanwhile draws it back, making it go the same way over again. Thus it moves to and fro with a velocity which would increase, if the earth's mass were to increase; and decrease, if the earth's mass were to decrease. Since the velocity of a pendulum may be measured very accurately by counting the number of vibrations it makes in a day, we are able also to calculate accurately the attractive power of the earth.

A few moments' consideration will make it clear to everybody, that the precise weight of the earth can be known so soon as an apparatus is contrived, by means of which a pendulum may be attracted by a certain known mass, and thus be made to move to and fro. Let us suppose this mass to be a ball of a hundred pounds, and placed near a pendulum. Then as many times as this ball weighs less than the earth, so many times more slowly will a pendulum be moved by the ball.

It was in this way that the experiment was made and the desired result obtained. But it was not a very easy undertaking, and we wish, therefore, to give our thinking readers in the next chapter a more minute description of this interesting experiment, with which we shall for the present conclude the subject.

CHAPTER III.

Table of Contents

DESCRIPTION OF THE EXPERIMENT TO WEIGH THE EARTH.

Cavendish, an English physicist, made the first successful attempt to determine the attractive power of large bodies. His first care was, to render the attraction of the earth an inefficient element in his experiment. He did it in the following way:

On the point of an upright needle he laid horizontally a fine steel bar, which could turn to the right and left like the magnetic needle in a compass-box. Then he fastened a small metallic ball on each end of the steel bar. The balls were of the same weight, for this reason the steel bar was attracted by the earth with the same force at both ends; it therefore remained horizontal like the beam of a balance, when the same weight is lying in each of the scales. By this the attractive force of the earth was not suspended, it is true; but it was balanced by the equality of the weights. Thus the earth's attractive power was rendered ineffective for the disturbance of his apparatus.

Next he placed two large and very heavy metallic balls at the ends of the steel bar, not, however, touching them. The attractive force of the large balls began now to tell; it so attracted the small ones that they were drawn quite near to the large balls. When, then, the observer, by a gentle push, removed the small balls from their resting-place, the large ones were seen to draw them back again. But as the latter could not stop if once started, they crossed their resting-point, and began to vibrate near the large balls in the same manner as a pendulum does, when acted upon by the attractive force of the earth. Of course this force was exceedingly small, compared with that of the earth; and for that reason the vibrations of this pendulum were by far slower than those of a common one. This could not be otherwise; and from the slowness of a vibration, or from the small number of vibrations in a day, Cavendish computed the real weight of the earth.

Such an experiment, however, is always connected with extraordinary difficulties. The least expansion of the bar, or the unequal expansion or contraction of the balls, caused by a change of temperature, would vitiate the result; besides, the experiment must be made in a room surrounded on all sides by masses equal in weight. Moreover, the observer must not be stationed in the immediate neighborhood, lest this might exercise attractive force, and by that a disturbance. Finally, the air around must not be set in motion, lest it might derange the pendulum; and lastly, it is necessary not only to determine the size and weight of the balls, but also to obtain a form spherical to the utmost perfection; and also to take care that the centre of gravity of the balls be at the same time the centre of magnitude.

In order to remove all these difficulties, unusual precautions and extraordinary expenses were necessary. Reich, a naturalist in Freiberg, took infinite pains for the removal of these obstacles. To his observations and computations we owe the result he transmitted to us, viz.: that the mass total of the earth is nearly five and a half times heavier than a ball of water of the same size; or, in scientific language: The mean density of the earth is nearly five and a half times that of water. Thence results the real weight of the earth as being nearly fourteen quintillions of pounds. From this, again, it follows that the matter of the earth grows denser the nearer the centre; consequently it cannot be a hollow sphere.