Physics for the 21st Century

Unit 3 Extra: Tabletop Cavendish Gravity Experiment

Wolfgang Rueckner

WOLFGANG RUECKNER: I have here in front of us a gravitational torsion balance, which is capable of measuring the gravitational attraction between little objects on the Earth. That is a very, very small force of attraction and so it's a very delicate balance. Inside this rectangular box there is a small dumbbell, which is suspended from a very, very thin quartz fiber about the thickness of a hair, which is attached to the top. The dumbbell can move back and forth but it doesn't move up and down.

So to see any movement of this little dumbbell we have a small mirror attached to it and a laser shines on that mirror and that laser light is reflected onto that blackboard up there. So the smallest movement of the mirror or the dumbbell will be seen as a movement of the spot of light that is reflected onto the blackboard. We have that spot of light far away from here to give us a large optical lever so very tiny movements will appear to be quite large up there.

Now the whole thing is extremely sensitive to vibrations because we're trying to measure an extremely small effect. And so it's all encased inside a box because we don't want air currents to move the dumbbell. We have it sitting on a very, very heavy steel plate, which is in turn sitting on some rubber balls to damp out any vibrations. And that is all sitting on a very rigid iron stand on a cement floor. So we're doing our best to cut out any vibrations.

We also don't want any electrostatic effects. If there is a charge that builds up on this box there may be an attraction of the dumbbell inside to the walls of the box because of the electrostatic effects. To prevent this, we have grounded the piece of apparatus so that no charge will build up.

So I have two very massive lead balls. They’re about 1.5 kilograms each. Now when we put two massive balls on the outside of the apparatus we can move those balls closer to the dumbbell and if there’s any gravitational attraction between the dumbbell and the two balls, then that will cause the dumbbell to feel a twist. That twisting motion can be shown by shining a light on this mirror and the reflected light that shines on the blackboard down there will indicate any motion of that dumbbell.

Now the laser beam will move on the blackboard as the dumbbell swings back and forth. It takes quite a while to complete one swing back and forth, about 8 minutes. And so it will continue to swing back and forth and eventually, meaning in less than an hour or so, settle down to its new position, which should be displaced from the original position indicated by the chalk mark on the board.