

THE GRIP OF GRAVITY

That ... one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it.

Isaac Newton (1693)

The theory of gravitation ... stands isolated from the other theories. Gravitation is, so far, not understandable in terms of other phenomena.

Richard Feynman (1985)

Despite its importance for us, for our biosphere, and for the cosmos, gravity is actually *amazingly feeble* compared with the other forces that affect atoms.

Martin Rees (2000)

Einstein's major discovery is that spacetime and gravitational field are the same object.

Carlo Rovelli (2004)

I have to have a sea view.

Yrsa Sigurdsdottir (2011)

The vertical drop from the office to my studio apartment is about five hundred feet, but it's not gravity that brings me daily to the bay. It's ocean addiction. I get antsy if I'm long away from sound of waves and scent of shore. Of course they mix with traffic spilling off I-10 and kelp pickling in brine puddles by the pier. And, surf-wise, Santa Monica's no Steamer Lane. But, for me, it is location, location and location. The apartment costs me thirteen hundred bucks a month. Travel takes three hours a day. It keeps me sane.

Sitting on cold sand at two a.m. and thoughts are churning. Physics has a long obsession with how matter moves in time and space. But gravity's what makes the universe go round. Frank needs perspective. How do I begin? It's a stubborn problem, one that numbs my mind.

Out of soft surf-sounds rise thoughts of romance, fleeting, but enough to tip me off. I'll tell him that Einstein's first fling happens with the photon. It leads to a long and difficult relationship. But gravity's his lifelong love. He tries and fails to get the two to get along. The photon's flighty. Gravity won't go for the *ménage*.

Gravity's a problem. For my clue list, I mean. But for now he needs to know a bit about it. After all, some physicists believe that understanding gravity and seeing how the universe began are the same issue, more or less. Another way to put it is that *the* theory, aka the Theory of Everything, should be a quantum theory of gravity.

For me the short-term problem is: What to tell him? I recall Twain said, or so they say, 'It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.' So tell him not too much, I'm thinking. There may be physicists who'd find *the* theory by lunchtime if they didn't know too much for sure already. But it shouldn't sully his naiveté to know what Rees is on about. It's not just that gravity *is* staggeringly feeble, though that is true. For example, take a proton and an electron. The mass of each attracts the other like the Earth and Moon. But this force is about 1,000,000,000,000,000,000,000,000,000,000,000 times weaker than the electric force between their charges. What Rees is saying is: It *must* be feeble or we wouldn't be here. The reason's simple. Both the electric force and gravity drop off with the square of distance. That is, they drop off fast, twice as far away, a quarter of the strength. But they don't drop off enough to stop a force—if it were strong—from causing havoc. Ten times stronger, we'd be squished.

So why doesn't the electric force cause havoc? Well, in *practice* it drops off far faster. Why? Because between *like* charges it is opposite. It repels. As my electron moves away, it doesn't see one proton. It sees a sea of protons and electrons. This makes the force a two-way street. In other words, once my electron moves a short way from the proton, push-pull forces cancel out. They have no long-range consequence at all.

But gravity's a *one-way* street. Forget the fudge that Einstein uses when he thinks he needs it to tune up cosmology. Gravity is an *attractive* force. Its long arm reaches right across the gaps between the galaxies. If it were a trillionth of the electric force, the universe would be a big black hole with every bit of mass and radiation tucked into its pointy basket.

She surprises me by asking for a printout of my notes. When she reads the bit about the universe as big black hole her eyes go just a little wider. She rescans these lines. She *reads* them. I mean, at most she barely skims the rest. Maybe I shouldn't try to read her. To me she is what Churchill said of Russia: A riddle wrapped in a mystery inside an enigma. Enigma is the word for this whole so-called office. But, anyway, it seems black holes and gravity can turn her crank.

So what to say of gravity? Well, without question, it's the central player in cosmology. This is written in the clear night sky. All that mass and more besides is waltzing around other mass in an elliptic manner. And the other mass likewise *ad*

almost *infinitum*. Gravity's the master of the cosmic dance.

Galileo gives it close attention. Newton gives it law. It's a pull exerted by a mass in one place on another in another. Or so he says, though, as he also says, he can't believe it. Einstein ends the action-at-a-distance nonsense. Gravity, he says, is just the curvature of space. It is what it is, right where it is. End of story. Except that this explains it using yet another thing he doesn't understand. I figure that what Frank needs, above all, is to understand *nobody* understands it. We don't know what space is. So, about gravity, if Einstein's right, we know diddly. And if he's wrong then we know squat.

And then there is the problem that it *will* be. But he will have to wait a while for that.