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mathematics; Is the Mandelbrot set like non-recursive mathematics?; Complexity theory; Complexity and computability in physical things 5 THE CLASSICAL WORLD The status of physical theory; Euclidean geometry; The dynamics of Galileo and Newton; The mechanistic world of Newtonian dynamics; Is life in the billiard-ball world computable?; Hamiltonian mechanics; Phase space; Maxwell's electromagnetic theory; Computability and the wave equation; The Lorentz equation of motion; runaway particles; The special relativity of Einstein and Poincare; Einstein's general relativity; Relativistic causality and determinism; Computability in classical physics: where do we stand?; Mass, matter, and reality; 6 QUANTUM MAGIC AND QUANTUM MYSTERY Do philosophers need quantum theory? Problems with classical theory; The beginnings of quantum theory; The two-slit experiment; Probability amplitudes; The quantum state of a particle; The uncertainty principle; The evolution procedures U and R; Particles in two places at once?; Hilbert space; Measurements; Spin and the Riemann sphere of states; Objectivity and measurability of quantum states; Copying a quantum state; Photon spin; Objects with large spin; Many-particle systems; The 'paradox' of Einstein, Podolsky, and Rosen; Experiments with photons: a problem for relativity? Schrodinger's equation Dirac's equation; Quantum field theory; Schrodinger's cat; Various attitudes in existing quantum theory; Where does all this leave us?; 7 COSMOLOGY AND THE ARROW OF TIME; The flow of time; The inexorable increase of entropy; What is entropy?; The second law in action; The origin of low entropy in the universe; Cosmology and the big bang; The primordial fireball; Does the big bang explain the second law?; Black holes; The structure of space-time singularities; How special was the big bang?; 8 IN SEARCH OF QUANTUM GRAVITY; Why quantum gravity? What lies behind the Weyl curvature hypothesis?

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#### Sommario/riassunto

For many decades, the proponents of 'artificial intelligence' have maintained that computers will soon be able to do everything that a human can do. In his bestselling work of popular science, Sir Roger Penrose takes us on a fascinating roller-coaster ride through the basic principles of physics, cosmology, mathematics, and philosophy to show that human thinking can never be emulated by a machine.

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