shock wave capable of cracking and fissioning off the explosion-modified mantle to form the Moon. An *in situ* Moon formed by self-gravitation would then be thrust through proto-Earth's surface, shattering the Moon surface to a certain depth and creating a temporary birth hole and signature effects on Earth. Such a violent lunar birth would also produce telltale explosive features on the Moon.

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■ **Stevenson replies:** I thank these letter writers for their alternative suggestions. Actually, neither is really new, and my failure to mention them—or others—is not because I was unaware of their existence, but rather because of the major challenges that these alternatives must overcome. In the Lagrange point scenario, which is widely known in the community, the challenge is to devise a story in which such bodies naturally arise in the context of a model that explains the planetary system, not just Earth–Moon. It is not sufficient to postulate them. A new paper[1] might suggest that the similarity of the impacting body and target is not so unreasonable. In the more astonishing fission story, the challenge lies in the basic physics of the proposed process, which is questionable.

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# Notes on the history of the Coriolis effect

A colleague recently shared with me some back issues of PHYSICS TODAY. In one of them (August 2011, page 8), Christopher Graney wrote that the deflection of moving objects seen from within a rotating frame of reference was described by Giovanni Riccioli and Francesco Grimaldi in 1651, nearly two centuries before Gaspard-Gustave Coriolis obtained his celebrated theorem on relative motion. But it should be pointed out that Riccioli and Grimaldi were elaborating on an argument discussed by Galileo Galilei two decades earlier, in 1632: In the second day of his *Dialogue Concerning the Two Chief World Systems*, Galileo explains,

> In shooting the cannon, it and the target are moving with equal speed, both being carried by the motion of the terrestrial globe. Although the cannon will sometimes be placed closer to the pole than the target and its motion will consequently be somewhat the slower, being made along a smaller circle, this difference is insensible because of the small distance from the cannon to the mark.[1]

Thus, whereas Galileo argued that the deflection produced by a rotating Earth was too small to be observed, Riccioli and Grimaldi argued that the lack of observation was proof of a steady Earth.

Continuing the discussion, Manuel López-Mariscal (PHYSICS TODAY, November 2012, page 8) wrote that it is well known that Pierre Simon Laplace used the Coriolis force in his study of ocean tides in 1775. Earlier instances of the use of the Coriolis force are not so well known: Euler's equations governing the motion of a liquid in a rotating tube and Clairaut's equations governing the constrained motion of two masses in a plane.[2] None of those antecedents should, however, undermine the fact that Coriolis's theorem is one of the great achievements of classical mechanics.[3] Sometimes it is cursorily stated that Coriolis derived the force acting in a rotating system, but his theorem actually gives the complete transformation of the equations of motion for any moving frame. So, for example, Jean-Baptiste Bélanger used Coriolis's theorem to study the motion relative to a translating system:[4] For uniform motion, he found that the equations are the same as in a system at rest (Galilean invariance), whereas for accelerated motion, he found that a uniform force field has to be added to the equations[5] (equivalence principle).

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# The roots of polaron theory

In his review of the book *Polarons* by David Emin (PHYSICS TODAY, October 2014, page 54), Jozef Devreese properly emphasizes the role of large polarons as both a general theoretical concept and a physical object. Polarons are electrons dressed by a cloud of virtual phonons in solids. To the best of our knowledge, they present the first example of propagating self-localized excitations in a quantum field theory. Devreese lists brilliant theorists who were inspired by the theory of polarons and significantly contributed to it, but he makes a serious omission when it comes to the roots of the polaron theory and the very origin of the term "polaron."

The general idea of electron trapping by a crystal lattice goes back to the seminal 1933 paper by Lev Landau.[1] That paper, which Devreese mentions, is primarily concerned with the resulting lattice defects, such as color centers in sodium chloride. Landau does not specify the trapping mechanism and contrasts a trapped electron with what he refers to as a freely moving electron.

The polaron was proposed, and the term coined, by Solomon Pekar. In two papers[2] published in 1946, he developed a self-consistent theory of a large polaron as a spontaneously trapped state of an electron strongly coupled to the induced polarization of atomic displacements in an ionic crystal. In his initial papers, Pekar considered polaron states to be "local," but in the follow-up papers[3] he identified polarons, rather than band electrons, as charge carriers in ionic crystals. That concept was developed and substantiated in a joint 1948 paper by Landau and Pekar in which they calculated the effective