On interplanetary shocks driven by coronal mass ejections

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Traveling interplanetary (IP) shocks were first detected in the early 1960s, but their solar origin has been controversial. Early research focused on solar flares as the source of the shocks, but when CMEs were discovered, it became clear that fast CMEs are the shock drivers. Type radio II bursts are excellent signatures of shocks near the Sun (Type II radio bursts were known long before the detection of shocks and CMEs). The excellent correspondence between type II bursts and solar energetic particle (SEP) events made it clear that the same shock accelerates ions and electrons. Shocks near the Sun are also seen occasionally in white-light coronagraphic images. In the solar wind, shocks are observed as discontinuities in plasma parameters such as density and speed. Energetic storm particle events and sudden commencement of geomagnetic storm are also indicators of shocks arriving at Earth. After an overview on these shock signatures, I will summarize the results of a recent investigation of a large number of IP shocks. The study revealed that about 35% of IP shocks do not produce type II bursts (radio quiet) or SEPs. Comparing the RQ shocks with the radio loud (RL) ones revealed some interesting results: (1) There is no evidence for blast wave shocks. (2) A small fraction (20%) of RQ shocks is associated with ion enhancements at the shock when the shock passes the spacecraft. (3) The primary difference between the RQ and RL shocks can be traced to the different kinematic properties of the associated CMEs. On the other hand the shock properties measured at 1 AU are not too different for the RQ and RL cases. This can be attributed to the interaction with the IP medium, which seems to erase the difference between the shocks.