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Flare Energy Release and Helioseismic Response

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Helioseismic response to solar flares (”sunquakes”) occurs due to localized force or/and momentum impacts observed during the flare impulsive phase in the lower atmosphere. Such impacts may be caused by precipitation of high-energy particles, downward shocks, or magnetic Lorentz force. However, the current theories of solar flares are unable to explain the origin of sunquakes. Our statistical analysis of M-X class flares observed by the Solar Dynamics Observatory during Solar Cycle 24 has shown that contrary to expectations, many relatively weak M-class flares produced strong sunquakes, while for some powerful X-class flares, helioseismic waves were not observed or were weak. The analysis also revealed that some active regions were characterized by the most efficient generation of sunquakes during the solar cycle. We found that the sunquake power correlates with maximal values of the X-ray flux derivative better than with the X-ray class, indicating that the sunquakes are associated with energetic particles. The impulsive nature of seismic flares hints that they are compact with a fast energy release rate, suggesting that low-lying short magnetic loops are involved in the flare-energy release process.

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