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The mechanisms of particle kinetics and dynamics leading to solar quakes

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The role of high energy particles for non-thermal excitation and ionization of the hydrogen atoms and the ambient plasma Coulomb and Ohmic heating is explored for different beam parameters and various atmospheric depths. On the one hand, only hard electron beams with high energy fluxes are found producing extensive non-thermal hydrogen ionization by 4 orders of magnitude higher than in the quiet atmosphere. This leads to the white light flares associated with seismic emission appearing simulataneously with hard X-ray emission. The excessive ionisation also leads to a strong increase on Ni line emission and formation of the seismic emission observed with the holographic technique. The hydrodynamic responses at the chromosphere caused by the beam electrons are maximised for moderate electron beams because of their strong Ohmic losses in the upper atmosphere for higher energy electron beams. As a result, the beam electrons form hydrodynamic shocks just below the transition region, in the upper chromosphere and they travel with a supersonic velocity for up to 5 minutes before can reach the photosphere. These types of shocks can explain the observations of solar quakes in M and C-class flares. For X-class flares high energy quasi-thermal protons or power law proton beams combined with electron beams are required to account for the observed magnitude of seismic responses.