Air shock waves from an asteroid entering the atmosphere: Venus, Mars and Earth

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The high-velocity entry of small asteroids to planetary atmospheres generates atmospheric shock waves able to create visible features of damage at the surface. On the Earth it can be an occasional damage of building (see the Chelyabinsk case 2013) or the prominent deforestation (see the Tunguska case, 1908). On Mars the tiny atmosphere results in a local surface dust relocation, visible as dark arcs elongated up to a few km, on Venus air shock waves from fragmented meteoroids create characteristic surface patterns. This work presents the analysis and unresolved problems of air shock wave interaction with planetary surfaces.

On Venus with the dense atmosphere a wide range of projectiles transfer projectile's kinetic energy to the atmospheric shock waves. In some cases, remnants of the dispersed projectile are able to reach and impact the surface. Numerical estimates show that impact-generated seismic waves overrun the atmospheric shock front. Consequently, at a specific distance from the interaction of seismic surface shaking and atmospheric shock impulse with positive and negative phases could create unusual surface disturbances. Some strange features visible on Venusian radar images potentially could be explained with an expanded shock/atmosphere interaction analysis.

On Mars, details associated with the surface dust displacement by air shock waves can provide important information about the structure of the near-surface layer of Martian soil.

The joint analysis of air shock waves on the terrestrial planets makes it possible to use the experience gained in registering the entry of meteoroids into the Earth's atmosphere to study the surface of Mars and Venus from observations from spacecrafts.