Interplanetary shock impact angle effects on geomagnetically induced currents

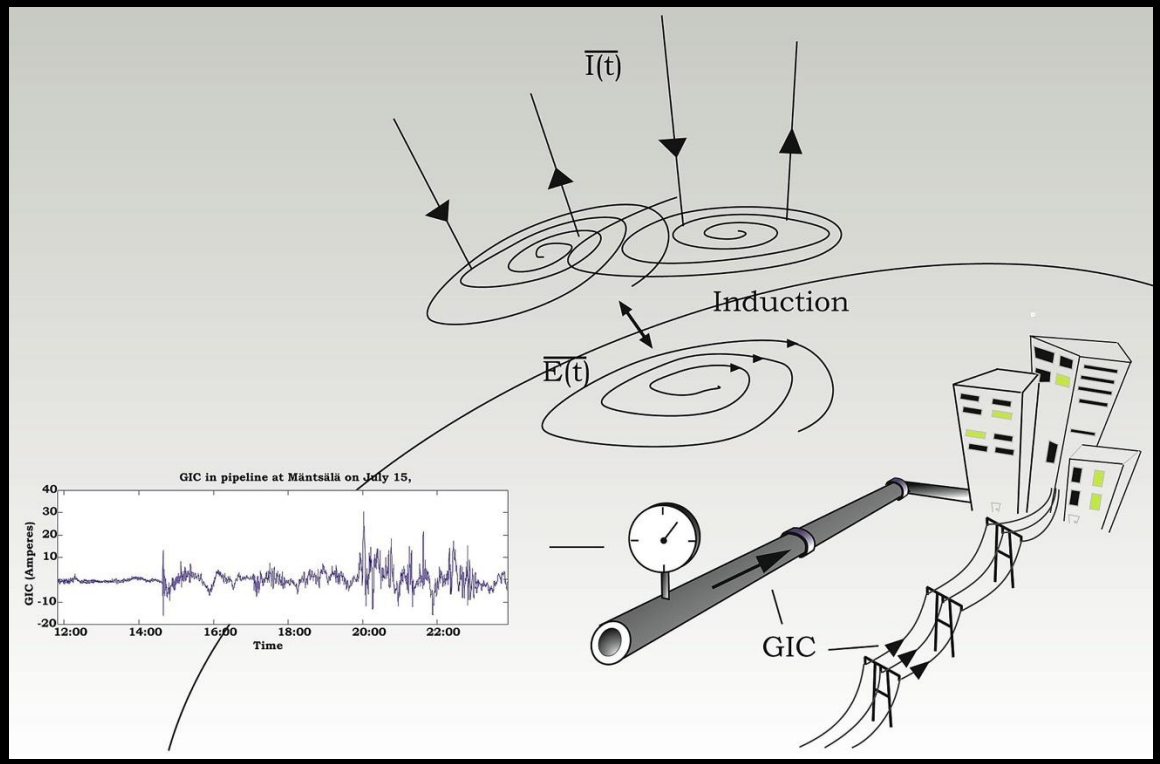
Interplanetary (IP) shocks can disrupt the Earth's magnetosphere and cause geomagnetically induced currents (GICs) that harm artificial ground conductors, including power transmission lines, oil/gas pipelines, railways, and submarine cables.

The shock impact angle influences the severity of geomagnetic activity, with nearly frontal shocks being more geoeffective.

This study examined 332 shock events and their impact on GICs recorded in Finland.

GIC peaks shortly after shock impacts are mainly caused by nearly frontal shocks and occur in the post-noon/dusk sector, likely due to partial ring current (a current that encircles Earth) intensifications.

More intense GIC peaks occur several minutes after shock impacts, around magnetic midnight, and are likely caused by energetic particle injections from the magnetotail during substorms.



The basic principle for the generation of GIC: variations of the ionospheric currents (I(t)) generate an electric field (E(t)) driving GIC. Shown are also real GIC recordings from the Finnish natural gas pipeline. (credit: Antti Pulkkinen/Wikipedia)

This work has direct implications for the prediction of GICs, one of the most destructive aspects of extreme space weather.

This work sparked at least 64 news stories, https://frontiers.altmetric.com/details/163223628/news

Denny Oliveira (UMBC/673), Eftyhia Zesta (673) and Sergio Vidal-Luengo (UC Boulder), 2024: "First direct observations of interplanetary shock impact angle effects on actual geomagnetically induced currents: The case of the Finnish natural gas pipeline system," Frontiers in Astronomy and Space Sciences, https://doi.org/10.3389/fspas.2024.1392697