

Low cost applications in astronomy, atmospheric science and communications using radio waves forward scattering from meteor trails

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The forward scattering of VHF radio signals by meteor ionized trails incorporates unique characteristics for usage in various applications. The oblique incidence of radio signals off the meteor trails enables the detection of fainter meteors using low-power transmitters. The relatively long duration of the scattered signals reflects the meteor trails behavior in relation to the atmospheric conditions near the meteor altitude region. It can also be used in communication of short bursts of data between distant locations on earth. In this research work, the usage of the forward scattering of radio waves by the meteor ionized trails in astronomy, upper atmospheric science and communication is presented. The developed meteor observation system follows the classical forward scattering setup commonly used worldwide. A methodology using locally developed software applications and interferometry technique to track the direction of each meteor echo is described as a fundamental step towards trajectory observations and hence meteor origins determination. Through using the same setup and software, the role of the secondary mesospheric ozone layer in oxidizing the meteor ionized trails was examined through meteor echoes duration distribution analysis during two meteor showers; the Perseids and the Geminids. Preliminary observations of the indirect link between solar cycle sun spot activity level and the meteor echo duration analysis is also presented. The observational research approach relies on extending the capabilities of the amateur basic setups by software automation in an attempt to fill the wide gap between the amateur systems and the professional ones. The gap that is mainly due to the difference in the amount of observational data each system can provide, can be partially filled through automation to provide enough data for statistical analysis. The methodology along with sample observational results for each application is described in detail as a proof of concept. The sample observational results in astronomy and upper atmospheric science applications are generally in agreement with the fundamentals of meteor science. Nevertheless, more statistical results are still required for further verification. In line with the observational activities, a practical meteor burst communication (MBC) study was performed to explore the feasibility of using modern technologies such as D-STAR ham-radio network and Android to simplify the MBC system. Although no positive results were obtained, the concept needs to be examined by higher power transmitters to compensate for the higher frequency used in the 144 MHz range. The three presented applications are not isolated from each other and the overlaps between them are highlighted. The low cost system setups introduced can be a model for low budget institutes planning to build a practical setup for educational as well as scientific purposes. The developed software applications are made free for use worldwide in order to support similar research themes.

Keywords: Meteor ionized trails, Radio Forward scatter, Interferometry