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INVESTIGATING THE INFLUENCE OF TILT ANGLE AND WIND SPEED ON THE AERODYNAMIC PERFORMANCE OF A 15M RADIO TELESCOPE USING CFD

Abstract

Radio telescopes contribute a major role in our understanding of the universe by enabling us to tap beyond the boundaries of visible light. Throughout their existence, radio telescopes have contributed immensely to the discovery of pulsars, quasars and various other celestial phenomena. They not only detect and collect radio waves from distant celestial objects even through the dust and gaseous clouds prevalent in space, but also provide the flexibility of operating 24/7 without being limited by the availability of sunlight. Radio telescopes can be installed either as single dish or as arrays and interferometers depending upon the resolution and sensitivity requirements as well as the level of complexity allowed. In Pakistan, there is no operational radio telescope as of now. The data received in Pakistan comes through various sources such as online data archives or through international astronomical collaborations to contribute to the astronomical research. In this respect, some universities in Pakistan have started to look into the possibility of collaborating with organizations to set up astronomical observatories comprising both optical and radio telescopes. This paper comprises a computational fluid dynamics study of 15m millimeter-wave radio telescope to understand its aerodynamic behavior with reference to the atmospheric conditions of the prospective location of a radio telescope observatory. Such radio telescopes preferably require higher altitude to obtain low radio interference and low water vapor with unobstructed line of sight for their optimal operations. Long term weather patterns are studied for the subject location to obtain its characteristics of the wind such as air pressure and air density. The values obtained are then applied as boundary conditions in the computational fluid dynamics analyses of a 15m radio telescope. A generic 15m parabolic reflector antenna is designed for the instant investigation. Different wind speeds and tilt angles of telescope reflector with respect to inbound wind are investigated. A grid independent study is also performed and a comparison is made with the analytical calculations to validate the results obtained numerically. Subsequently, the pressure distribution loads are obtained for stress investigation of the telescope using FEM. This study aims to aid in the selection of a feasible location for the astronomical observatory and the design of a 15m radio telescope in relation to structural and aerodynamic point of view by providing appropriate data to the decision makers, and thereby, contributing to the astronomical research in Pakistan and benefiting the field of astronomy at large.