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A Mach Zehnder Interferometer as a Tool for Measuring Aerosol Light Absorption

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Aerosol affects radiative forcing in a different way depending on the interaction between the aerosol and cloud. The aerosol directly affects the radiative forcing through the light absorption or light scattering by the aerosols. Aerosols included in the atmosphere help to form clouds which scatter the solar light back toward stratosphere. The aerosols act as nuclei that initiate condensation of vapor into cloud. The aerosol elongates the lifetime of cloud, affecting the radiative forcing indirectly. Among aerosols, black carbon attracts great attention because the black carbon forcing could be even as much as 55% of the CO2 forcing (Ramanathan and Carmichael, 2008, Nature Geoscience). Thus, it is very important to better understand the effect of black carbon on radiative forcing. Currently, filter based technique has been widely used for measuring the aerosol light absorption. The present study introduces an optics based technique, photothermal interferometry, in order to determine the aerosol absorption coefficient. The aerosol light absorption is measured by utilizing a Mach Zehnder interferometer and by analyzing the changes in the image of interference pattern created by thermal absorption surrounding aerosols. Preliminary experiments demonstrated that the image-based photothermal interferometry would be a useful method for measuring aerosol absorption. The Mach Zehnder interferometer provides a simple unit for the detection of aerosol as well as gas species. The Mach Zehnder interferometer consists of a CCD camera, two mirrors, two beam splitters and two right angle prisms. Changes in the fringe pattern created by aerosol light absorption were observed in real time. The brightness and darkness of the interference fringe were converted into intensity, which was used to calculate the aerosol absorption coefficient. The detection limit of the interferometer used in the current study is estimated to be 3.3 Mm-1 at 1 second averaging time. We discuss the performance, advantage and disadvantage of the Mach Zehnder interferometer used in the present study. The caveat is that the flow inside the sample cell should be laminar. A design concept will be suggested for stabilizing the flow pattern inside the sample cell. The performance of the present instrument will be improved by employing a high resolution CCD camera. Additionally, aerosol absorption coefficients measured by the Mach Zehnder interferometer will be compared to those measured by a filter based instrument such as a multi angle absorption photometer. We conclude that the Mach Zehnder interferometer can be used to measure the absorption coefficient in an area where the absorption coefficient is above the detection limit of our instrument.