

A proposal of simple resonance scattering lidar using an alkali metal vapor laser for monitoring the MLT region

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Many observations of metal atomic layers such as Na, Fe, K, Ca and Ca ion in the mesopause region have been conducted in many parts of the world. We have observed several mesospheric metallic layers at Tokyo and Indonesia using resonance scattering lidars consisting of a dye laser and a Ti:Sapphire laser [1]. Especially, in order to solve the formation mechanism of metallic sporadic layers occurred in the mesopause region, the simultaneous observation of Ca ion and the neutral metal atom is necessary. However since the output power of the Ti:Sapphire laser has a low damage threshold of a crystal, it is difficult to improve the output average power. We propose the resonance scattering lidar consisting of the alkali vapor laser for monitoring the MLT region. Optically pumped alkali vapor lasers have attracted increasing attention because of their potential of achieve high power in a high quality beam. The alkali vapor laser can easily realize narrow-linewidth and precise tuning.

Metal atomic layers in the mesosphere are an excellent tracer of the atmospheric wave motion in the region between 80 and 100km. sudden formation of thin metallic layers, superposed in the background mesospheric metallic layers was discovered and these enhanced layers are called the sporadic metallic layers. We have observed frequently the sporadic sodium layers (Nas) at Hachioji, Japan (35.6N, 139.4E) and the sporadic sodium and iron layers (Fes) at Kototabang, Indonesia (0.2S, 100.3E). The ion recombination mechanism invoking wind shear and sporadic E layers appears to be consistent with many observed characteristics, but their cause is still an open question.

Zhdanov et al. presented optically pumped continuous wave potassium vapor laser operating in a single longitudinal and a single transverse mode at 770 nm [2]. Zweiback et al. demonstrated a high efficiency potassium vapor laser using a 0.15nm bandwidth alexandrite laser as the pump source [3]. The alkali vapor laser operates in a three level scheme. The optical pump source excites the D2 line of alkali atom and lasing occurs on the D1 line. To provide a population inversion, fast quenching must be provided by using a buffer gas. We are developing a high peak power pulsed potassium vapor laser using alexandrite laser as the optical pump source. Sealed potassium vapor cell had AR coated windows, and filled with metallic potassium and helium. The cell was assembled inside an oven which had temperature controlled heaters. A pump beam polarized in the horizontal plane was focused through the polarizing beam splitting cube into the potassium vapor cell with a lens. A laser cavity was created for the vertical polarization by two mirrors and the beam splitting cube.

The development of these kinds of lasers is identified as one of the key topics for advancing the application of resonance scattering lidar systems.

References

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