A 780 nm Voigt laser inherently corresponding to atomic transition line

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Semiconductor lasers with narrow linewidth, whose frequency correspond to atomic transition lines, are highly suitable as laser sources for atomic-related experiments in the fields of atomic physics and quantum precision measurement. Typically, achieving a narrow linewidth laser can be accomplished by incorporating frequency-selective elements, such as interferometers or gratings, before the optical feedback mirror. However, the frequency of these lasers is depended on the angle of the frequency-selective element, necessitating precise adjustment to correspond with the desired atomic transition line. Moreover, long-term continuous operation may introduce external vibrations and temperature fluctuations that can disrupt the position of these frequency-selective components, requiring manual intervention for restoration.

In this study, by employing a Voigt anomalous dispersion optical filter (VADOF) as the frequency-selective element, we present a semiconductor laser that inherently correspond to the Doppler broadening line of 780 nm D2 line of ^{85}Rb atoms, which is named as "Voigt laser". Similar to semiconductor lasers utilizing Faraday anomalous dispersion atomic filters for frequency selection, the Voigt laser's output frequency is confined within the 1 GHz bandwidth range of the atomic filter and consistently matches the atomic transition[1]. Importantly, these lasers exhibit exceptional resistant against variations in diode current and temperature, enabling they to maintain alignment with the atomic transition line during long-term operation without human intervention. Moreover, in this implementation of the VADOF, magnets are positioned radially inside the atomic vapor cell, ensuring that magnet size does not impact the length of the laser cavity, thereby facilitating miniaturization and portability[2]. The Voigt laser will significantly contribute to realizing portable and ready-to-use high-precision atomic devices.

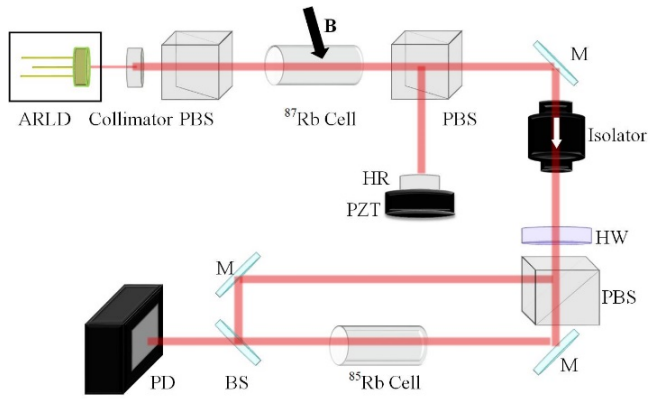

Fig. 1: Schematic of the experimental setup.

[1] X. Miao, "Note: Demonstration of an external-cavity diode laser system immune to current and temperature fluctuations", Rev. Sci. Instrum., vol. 82, p. 086106, 2011.
[2] Z. Liu, "An atomic filter laser with a compact Voigt anomalous dispersion optical filter", Appl. Phys. Lett., vol. 123, p. 131103, 2023.