Application of directly modulated diode laser and polarimetric technique to observation of sub-Doppler resonances in small Cs vapor cell

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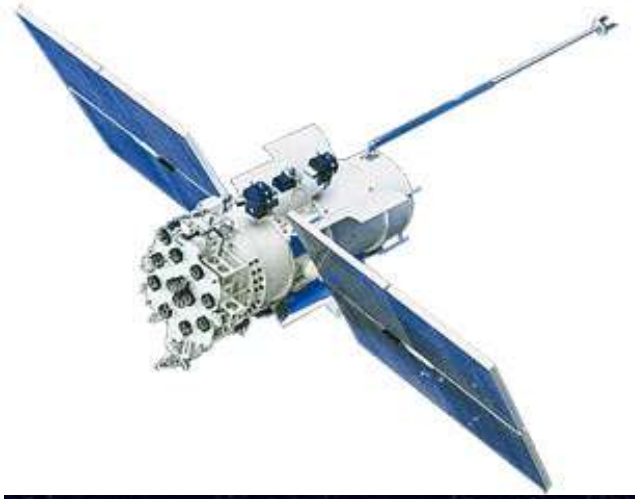
Introduction

- The frequency standards are widely used in high-resolution spectroscopy, precision physics experiments
- Metrology, location, geophysics, space exploration
- One of the main methods of laser spectroscopy is method of saturated absorption in a gas of alkali metal atoms



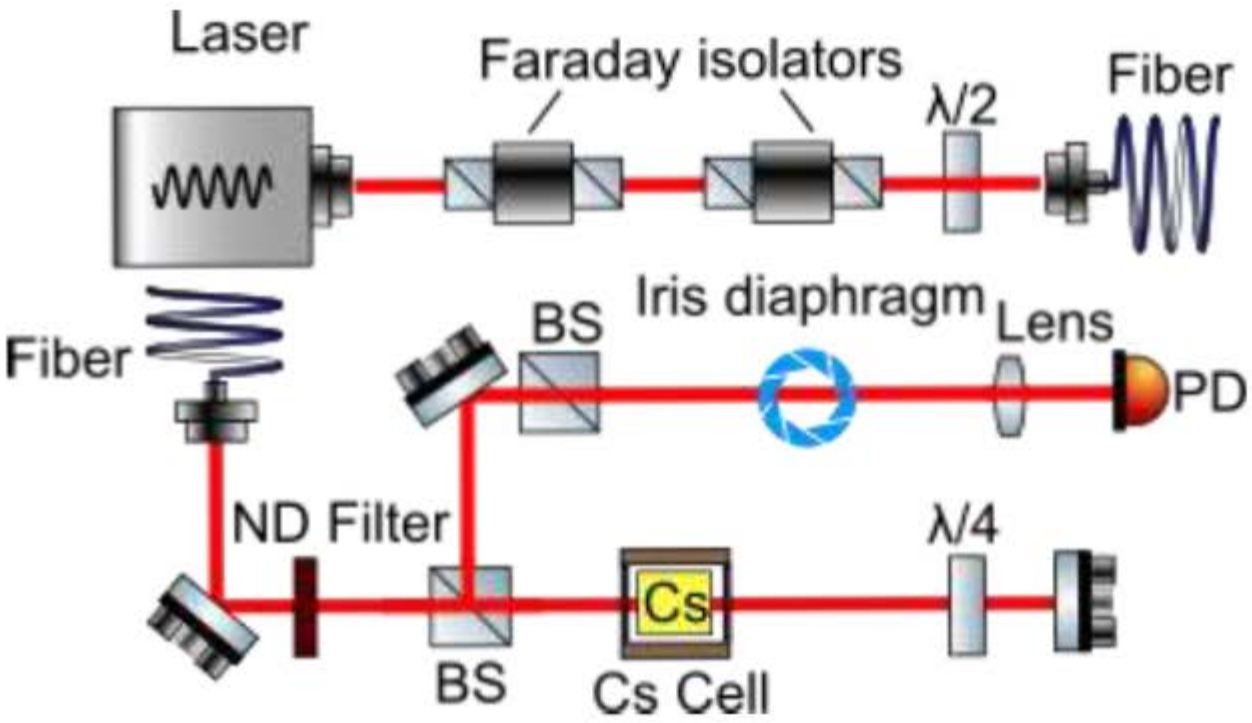
Relevance

- High-contrast sub-Doppler resonances is observed in vapors of alkali metal atoms in the field of colliding bichromatic laser beams have good prospects in quantum metrology for creating a miniature **optical frequency standard**
- Until recently, the most compact (miniature) CFS samples were developed only for the microwave range. In such devices, the frequency of the microwave generator, on the order of several GHz, is stabilized by the resonances of coherent population trapping (CPT)

Design

- The problem of compactification of a scheme variant with two-frequency spectroscopy, in which an EOM is used to generate side modulation bands.
- EOM adds very large dimensions to the installation.
- Therefore, work is began on conducting a series of experiments to remove the EOM from the circuit and using direct modulation of the DBR current to obtain the same good results.
- But with direct modulation, there are many sidebands that degrade contrast and add noise.
- **To solve this problem**, the idea arose to use a scheme with differential registration of resonances, in which all non-resonant sidebands are subtracted, and the amplitude of the resonance becomes larger again.
- In addition, this subtraction helps to reduce the amplitude noise (RIN), because it is the same on both channels of the balanced photodetector.

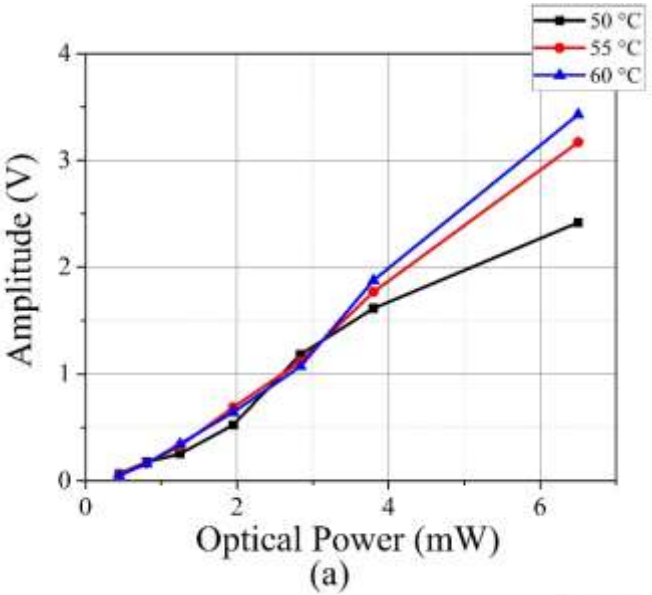
Installation scheme

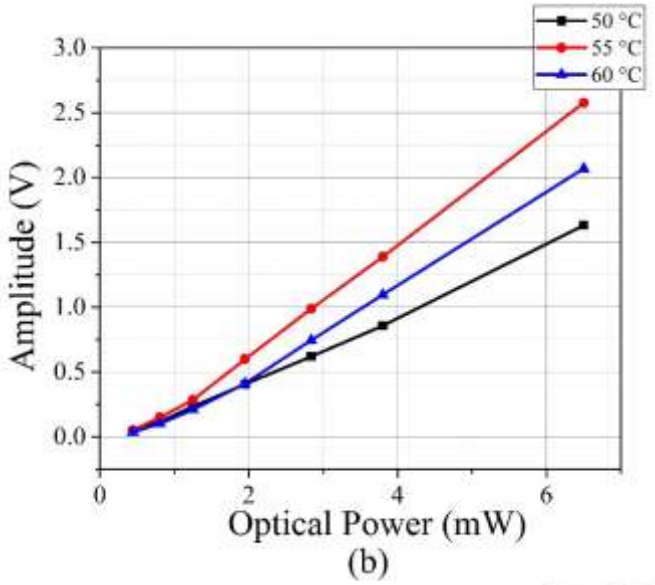


BS-Beamsplitters, ND-neutral density, PD-photodetector

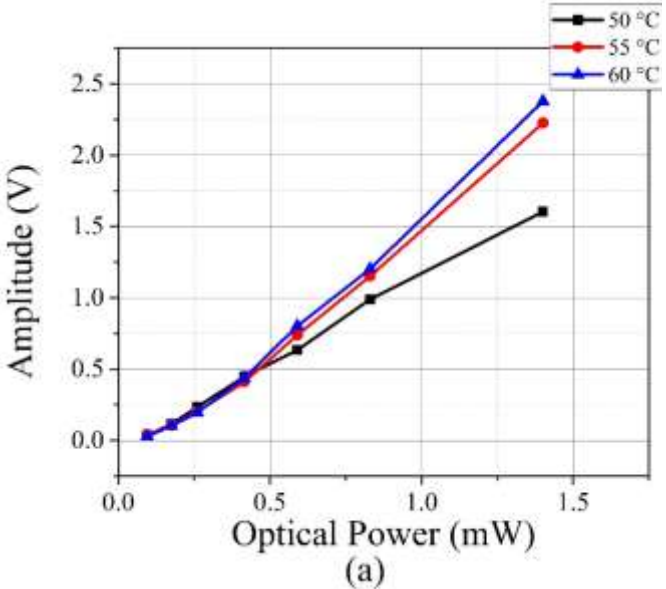
Resonance amplitude (a) in polarimetric technique of registration and (b) in regular absorption technique at different cell temperatures

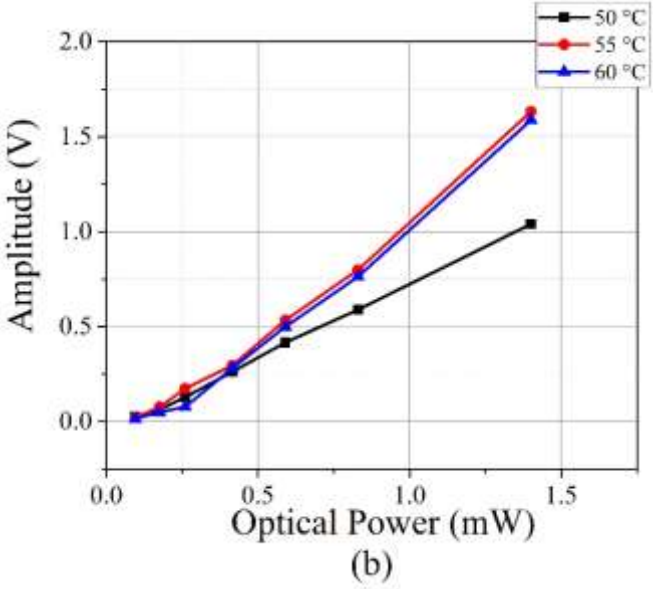
- Direct modulation





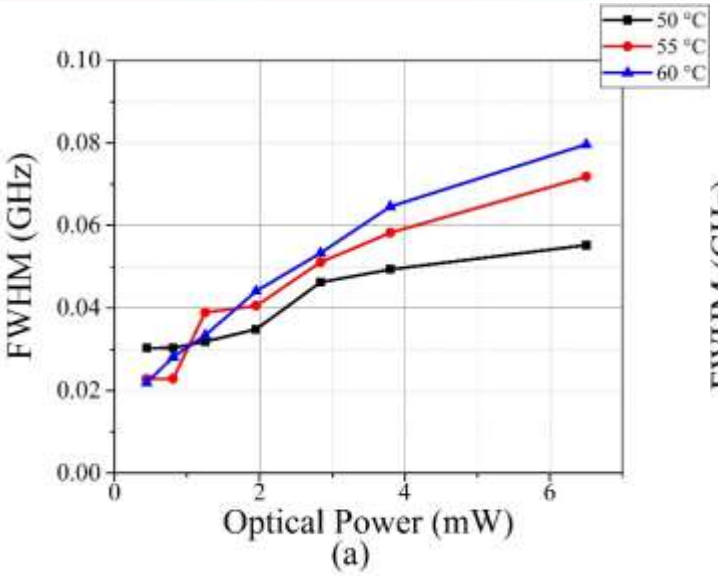
- EOM modulation

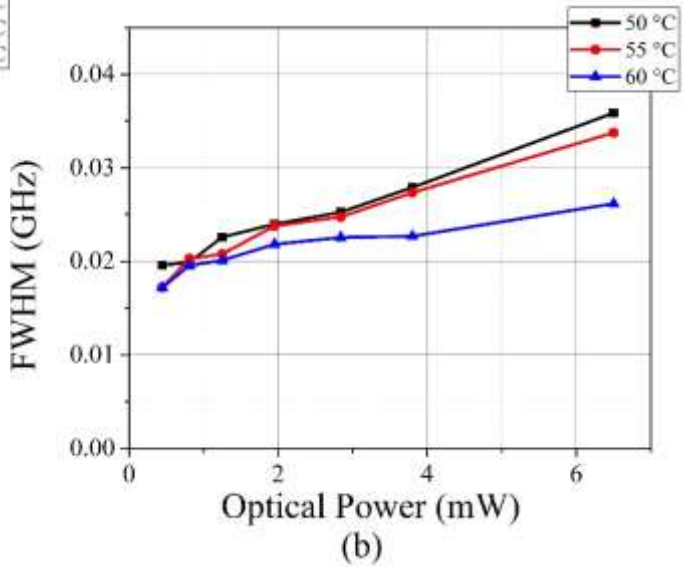




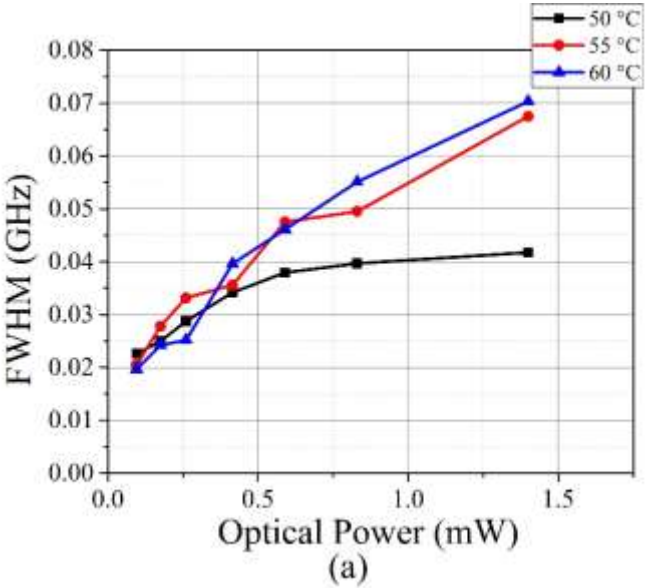
Resonance width (a) in polarimetric technique of registration and (b) in regular absorption technique at different cell temperatures

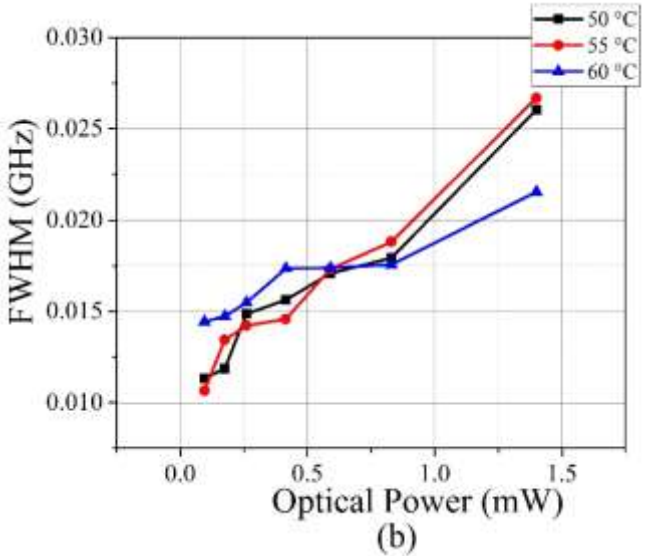
- Direct modulation



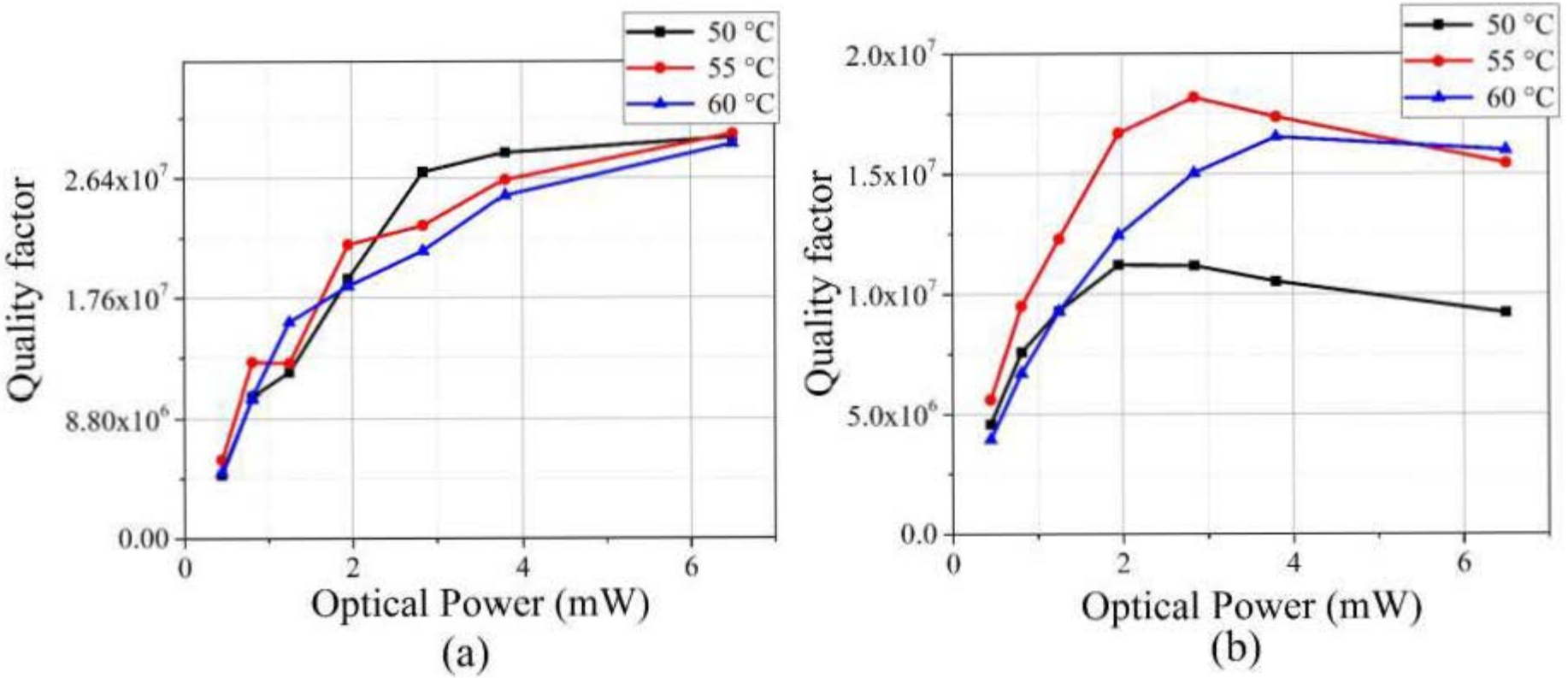


- EOM modulation



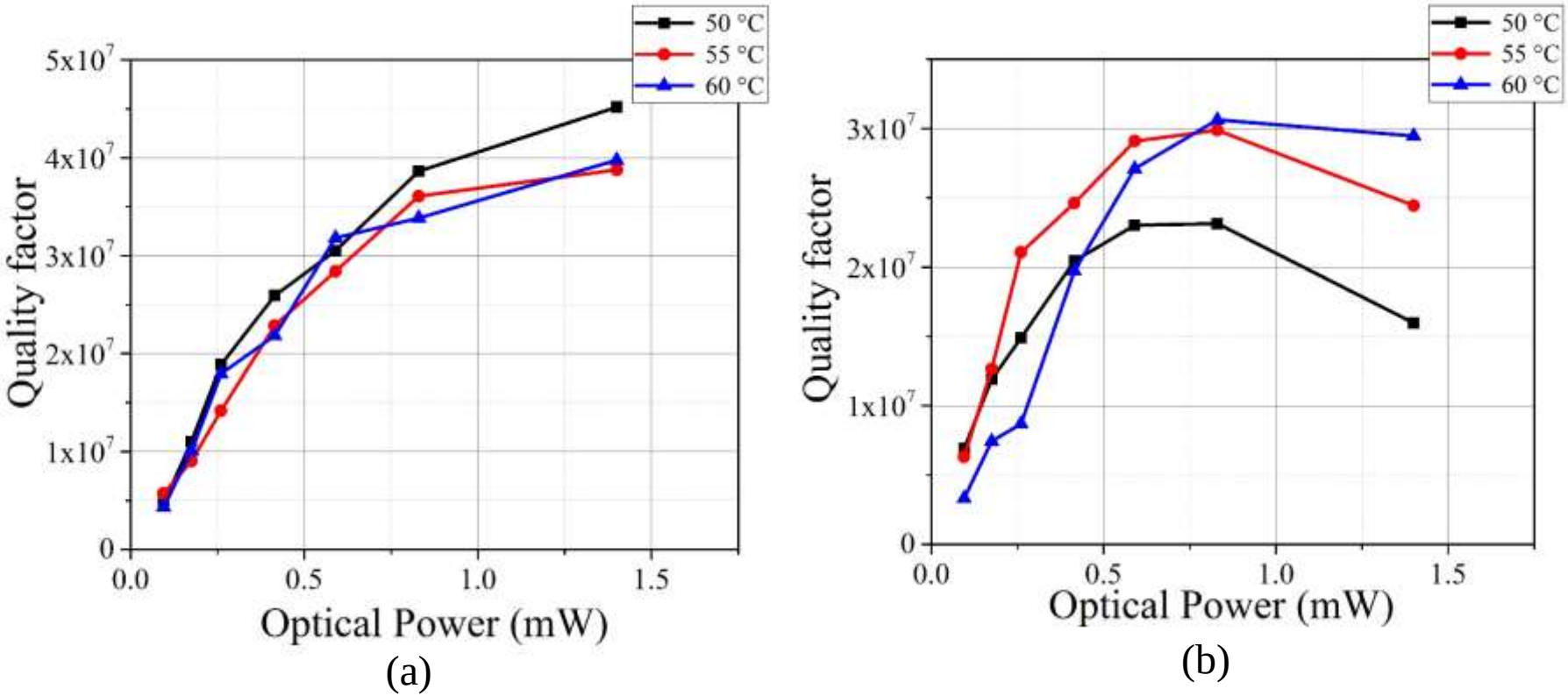


Polarimetric technique for the resonance observation direct modulation



(a) Quality factor in polarimetric technique of registration and
(b) in regular absorption technique at different cell temperatures.

Polarimetric technique for the resonance observation EOM modulation



(a) Quality factor in polarimetric technique of registration and
(b) in regular absorption technique at different cell temperatures.

Conclusion

- Comparison of the quality factor Q between the two detection methods, it turns out that in a circuit with a balanced photodetector it is larger
- With the EOM circuit, you can see that the quality factor is comparable to the direct modulation scheme
- The resonance parameters in schemes with direct modulation and EOM modulation are comparable
- Therefore, the EOM can be excluded, which will help in miniaturizing the circuit

- *Thank you for your attention!*