Laser line shape and spectral density of frequency noise

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Abstract: Published experimental results show that single-mode laser light is characterized in the microwave range by a frequency noise which essentially includes a white part and a 1f (flicker) part. We theoretically show that the spectral density (the line shape) which is compatible with these results is a Voigt profile whose Lorentzian part or homogeneous component is linked to the white noise and the Gaussian part to the 1f noise. We measure semiconductor laser line profiles and verify that they can be fit with Voigt functions. It is also verified that the width of the Lorentzian part varies like 1P where P is the laser power while the width of the Gaussian part is more of a constant. Finally, we theoretically show from first principles that laser line shapes are also described by Voigt functions where the Lorentzian part is the laser Airy function and the Gaussian part originates from population noise.
Index Keywords: Atomic physics; Functions; Molecular physics; Natural frequencies; Semiconductor lasers; Spurious signal noise; Frequency noise; Laser line shape; Spectral density; Voigt functions; Laser theory

Year: 2005
Source title: Physical Review A - Atomic, Molecular, and Optical Physics
Volume: 71
Issue: 4
Art. No.: 43809
Page : 1-9
Cited by: 10
Link: Scorpus Link
Correspondence Address: Stéphan, G.M.; Laboratoire d'Optronique Associé, Centre National de la Recherche Scientifique, ENSSAT, 6 rue Kerampont, 22305 Lannion Cedex, France
ISSN: 10502947
CODEN: PLRAA
DOI: 10.1103/PhysRevA.71.043809
Language of Original Document: English
Abbreviated Source Title: Physical Review A - Atomic, Molecular, and Optical Physics
Document Type: Article
Source: Scopus
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