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12.3 D. Faubert, P. Galarneau & S. L. Chin, "An electro-optical technique to vary continuously a laser pulse", <i>Optics and Laser Technology</i> (April 1981) pp. 79-82.	326
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S. L. Chin, "Laser Beam Transport" in <i>Laser Applications in Physical Chemistry</i> , ed. D. K. Evans, Marcel Dekker, Inc., N. Y., 1989, pp. 39-62	
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