

Selective reflection from dense Rb₂ molecular vapor

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Selective reflection (SR) of light from an interface of a dielectric window and atomic vapor is known as a powerful spectroscopic tool for numerous applications [1]. Extension of this technique to molecular vapor is a challenge, mainly due to technical problems.

We report the first observation of SR from molecular vapor of Rb₂ dimers formed in all-sapphire sealed-off rubidium vapor cell at the temperature range of 455 – 515°C corresponding to number density of Rb₂ dimers $6.7 \times 10^{15} - 2.6 \times 10^{16} \text{ cm}^{-3}$. The selective reflection signals were recorded on various rovibronic components of $1(X)^1\Sigma_g^+ - 1(A)^1\Sigma_u^+$ bound-bound electronic transition of Rb₂ (left graph in Fig.1) by scanning a diode laser frequency in a spectral range of 851 – 854 nm ($11710 - 11750 \text{ cm}^{-1}$). Mainly selective reflection spectra corresponding to groups of several rovibronic transitions have been recorded, which is caused by high spectral density, large collisional broadening, and low oscillator strength of individual rovibronic transitions.

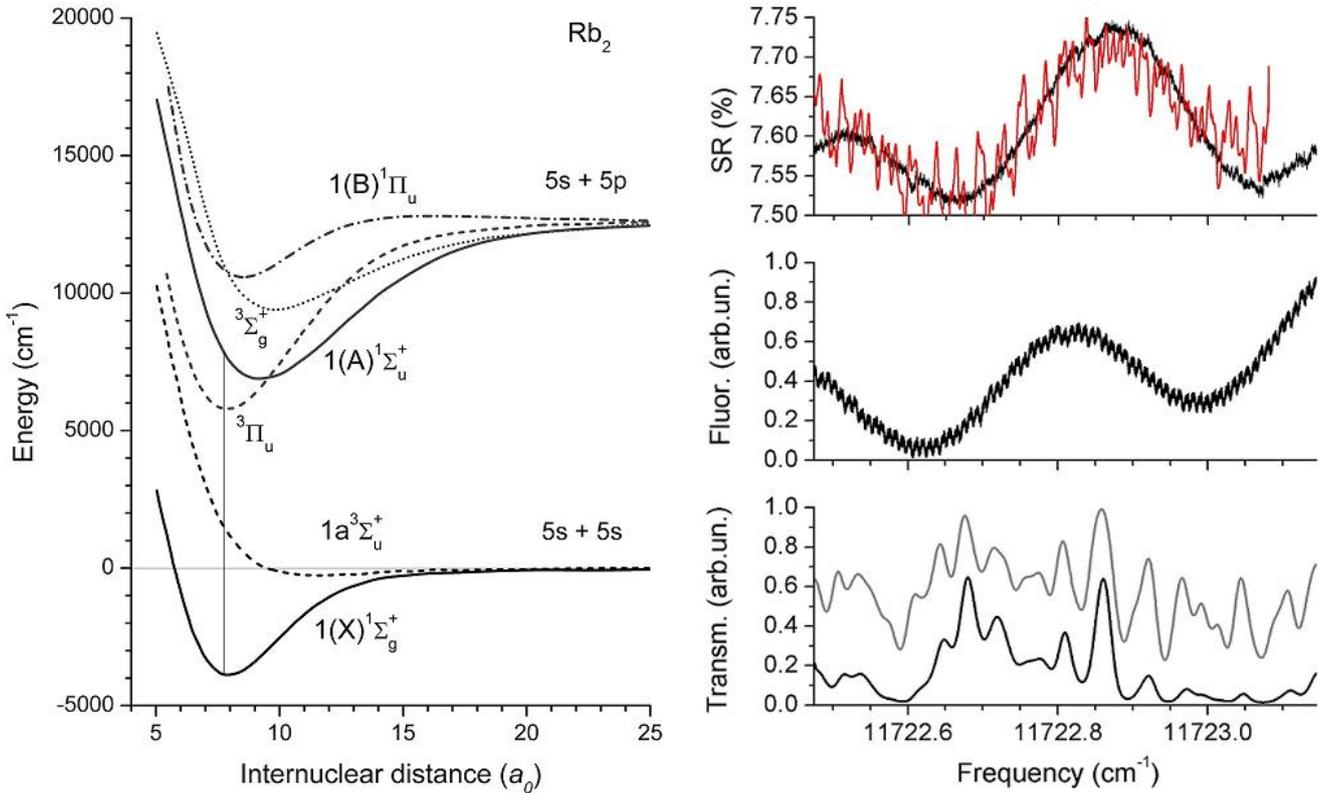


Figure 1: *Left:* Rb₂ potential curves for lower electronic states relevant for the present study. Vertical line indicates molecular electronic interstate transition with 852 nm wavelength. *Right:* Rb₂ selective reflection (upper graph) and fluorescence (middle graph) spectra recorded at $T = 461^\circ \text{C}$, $N_{\text{Rb}_2} = 9.3 \times 10^{15} \text{ cm}^{-3}$; transmission spectra (lower graph) recorded at $T = 310^\circ \text{C}$, $N_{\text{Rb}_2} = 7.0 \times 10^{13} \text{ cm}^{-3}$ (upper trace) and $T = 400^\circ \text{C}$, $N_{\text{Rb}_2} = 1.7 \times 10^{15} \text{ cm}^{-3}$ (lower trace). Colored noisy signal superimposed on measured SR spectrum presents the SR spectrum derived from fluorescence by data processing (see text).

We have proved that the recorded signals shall be attributed to selective reflection by careful alignment of the measurement setup, as well as by comparison of the experimentally recorded SR spectrum with the modeled one derived from the simultaneously measured fluorescence spectrum using Kramers-Kronig relation and Fresnel formula (right graph in Fig.1).

References

[1] A. Badalyan *et al.*, Eur. Phys. J. D **37**, 157–162 (2006).