Renaissance in diatomic spectroscopy

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Abstract. New technological developments resulted in several periods of renaissances of spectroscopy, like microwaves and later lasers, and lead to developments of new models for description of observations, thus to understanding the underlying physics. Today, the exciting period of cold molecules has started and demands for new data from molecular spectroscopy and completion in their modeling.

This contribution will describe the status of understanding before the era of "cold molecules" and note open questions when entering the field of cold molecules. Because large varieties of cold molecules are studied, like deeply bound (about 1eV) or very weakly bound (less than 1μeV) ones, the spectroscopic tools and the theoretical descriptions have to be largely extended. We will describe recent success regarding different molecules of diatomic alkali- and alkaline-earth atoms as examples and will learn how to use the often huge body of spectroscopic data for obtaining predictions for optimal paths to produce ultra cold molecules in a desired molecular state.

It is very exciting to combine the results of spectroscopy and of studies of ultra cold ensembles which are influenced by their atom-molecule changeover. This allows already to complete the understanding of the electronic structure of atomic pairs from infinite internuclear separation to the range of strongly overlapping electronic distribution in some cases (e.g. KRb or KCs), but asks for enhanced effort for describing quantitatively the discoveries, already published or expected, like a contribution to the field of time dependence of fundamental constants. For molecules with their rotational and vibrational motion the ratio of electron-to-nuclear mass as a fundamental constant shows up as an obvious attraction for spectroscopic studies.