**Non-steady state collision-radiative models   
for atmospheric pressure plasma diagnostics**

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The discharge mechanisms generating atmospheric pressure plasmas lead to their highly transient behavior with steep gradients on sub-millimeter and sub-nanosecond scales. These plasmas, generated by barrier, corona, or spark discharges, or in nanosecond pulsed or jet discharges, are useful in many application-oriented fields of research. Particularly, the interest is focused on plasmas in gases like air or argon, which have an exclusive position both in nature and technology. For proper understanding of such plasmas, closely linked diagnostics and computer modelling approaches are necessary. We summarize the use and basic principles of these approaches in the past and present recent methods for development of non-steady state collision radiative models for such plasma investigations and their results for relevant gas-mixtures. Applying these models, we unravel the changes in a local electric field parameter with high spatiotemporal resolution, using linked experimental and theoretical efforts. The experimental part comprises the utilization of usual (ICCD cameras) as well as less common (time-correlated single photon counting systems) devices for detailed plasma diagnostics. The theoretical part uses procedures of sensitivity analysis, uncertainty quantification, enhancement of reaction kinetics models or fluid modelling of discharges selected for the case studies. Only such joint procedure can lead to the knowledge clarifying in detail the underlying plasma physical mechanisms and plasma chemical processes on aforementioned small temporal and spatial scales.

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