The interaction of a pulsed laser beam with any sample (laser ablation) creates a transient optical source (plasma), in which chemical information of the sample is contained. Laser-ablation based optical-emission methods [e.g., laser induced breakdown spectroscopy (LIBS) and laser-ablation molecular isotopic spectrometry (LAMIS)] are versatile tools for direct and fast chemical analysis at atmospheric pressure, for virtually any type of sample with minimal sample preparation. Furthermore, the ability to perform standoff or remote analysis is a unique advantage of photon-emission based measurement over other analytical techniques (e.g., mass spectrometry).

It has been recognized long ago that atomic transitions of the same element but from different isotopes emit light at slightly different wavelengths. This isotopic shift allows the different isotopes to be analysed by means of atomic optical spectrometry. Currently, most LIBS measurements are utilized only for elemental analyses; however, LIBS also can provide isotopic information, at least for elements that exhibit large isotopic shifts (e.g., uranium). The development of the LAMIS technique further enhances the capability of laser-induced plasma for isotopic analysis.

LAMIS measures the molecular emission spectra of those radicals that are formed at a late time scale in the plasma, when ablated atoms begin interacting with atmospheric species to create excited-state molecules (e.g., oxides). As molecular spectra typically exhibit two to three orders of magnitude increase in isotopic shift compared to atomic transitions, the shift can be readily measured with a relatively low-resolution optical spectrometer.

In this presentation, the theoretical principles of LIBS and LAMIS for isotopic analysis will be overviewed, the current status (e.g., analytical figures of merit as well as challenges) of the techniques will be examined, and some application examples will be discussed.