Probing anion resonances in FeO^-: a species of astrophysical relevance

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Synopsis We report the first experimental probe on resonance states in FeO anion, a molecule of astrophysical relevance. Excitation of FeO^- through collision with argon was performed to measure the kinetic energy release in the centre of mass frame. Results show access of two anion resonances upon collisional excitation. We discuss our evaluation of these two resonances from kinetic energy release in the centre of mass frame. The astrophysical importance of these anion resonances will be presented.

FeO is the first iron-bearing molecule discovered in the inter-stellar medium (ISM) [1], [2]. Depletion of refractory elements in the ISM motivates the search and study of iron-bearing ISM molecules. Recently, another iron-bearing molecule, FeCN was unambiguously identified in the envelope of carbon-rich asymptotic giant branch star, IRC+10216 [3]. Although ISM anions were predicted in 1981 by Herbst *et. al.* [4], only in 2006 the first ISM anion C_6H^- was detected [5]. This was followed by recent detections of CN^-, C_3N^-, C_4H^-, C_6H^-, C_8H^- and C_5N^-. Anion resonances are states embedded in the detachment continuum and are short-lived states. They are formidable to study theoretically due to high electron correlation. Hence experimental investigations such as dissociative electron attachment [6], collisional or photoexcitation become important to probe these resonances. In the present work, we have probed FeO^- which is detected in its neutral state in the ISM. Resonance states of FeO^- can be accessed by electron attachment to FeO in the ISM and would result in autodetachment or dissociation. Anion resonances thus critically determine the ISM reactions and relative abundances of various ISM species.

FeO^- were produced in Cs-sputter source and were accelerated to 15keV and eventually collided with Argon in a collision cell. The collisionally excited anion dissociates and the anionic daughters scattered in the forward and backward directions were only detected using an energy analyser. Two daughter anions were detected in our experiments as shown in the figure. The kinetic energy(KE) released in the center of mass frame was evaluated from the lab frame KE release. The energy released in the center of mass frame for both the daughter anions were different, indicating access of two different anionic states in this experiment. In our recent work on FeC anions we have observed two anion resonances [7]. We have evaluated the ground state of the FeO^- and its vibrational wavefunctions using LEVEL program [7]. We employ reflection method, on the CM frame energy release to deduce the two anion resonances accessed in our experiment. Our results are of paramount importance in studying the disscociation dynamics involving iron containing ISM molecules. The important implications of our results to astronomy will be discussed in the presentation.

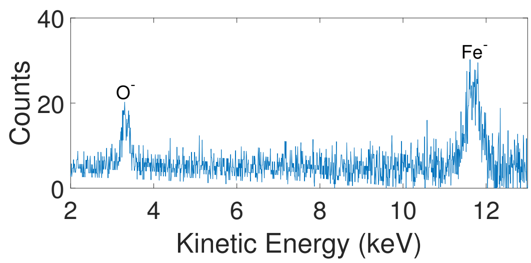

Figure 1. Daughter-ion peaks recorded for the CID of FeC^- anion

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