The first observation of the free induction signals of OH radicals in the terahertz region.

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Hydroxyl radical OH is the main oxidizing agent in combustion processes and in atmospheric chemistry. The rotational spectrum of OH is comparatively simple - there are less than 10 absorption lines in the therahertz region, corresponding to transitions between the lower rotational states of the radical. The FID signal was observed at the OH absorption line at 83.8 cm^{-1}, that corresponds to the transition from the lowest rotational state of OH. Hydroxyl radicals were generated in the following sequence of chemical reactions:

$$O_3 + (h\nu = 266\ nm) \rightarrow O(^1D) + O_2 \quad (1)$$

$$O(^1D) + H_2O \rightarrow 2\ OH \quad (2)$$

$$OH + OH \rightarrow H_2O + O \quad (3)$$

The concentration of OH radicals was ~ 10^{15} cm-3, lifetime ~ 300 …. 700 mks.

The pulse of UV laser (266 nm) was synchronized with the FEL pulses. Shape of the FEL pulse with FID signal after the optical cell was recorded by an ultrafast Schottky diode detector and 30GHz oscilloscope[1]. The The experiment was organized similarly to our work on ultrafast timedomain spectroscopy [2-18].

Fig.1 shows the first experimentally observed FID signal of a hydroxyl radical, accumulated at 500 mks after the UV pulse The moment t = 0 corresponds to the input FEL pulse. The signal from the laser pulse was accumulated separately, in the absence of radicals., and was subtracted .

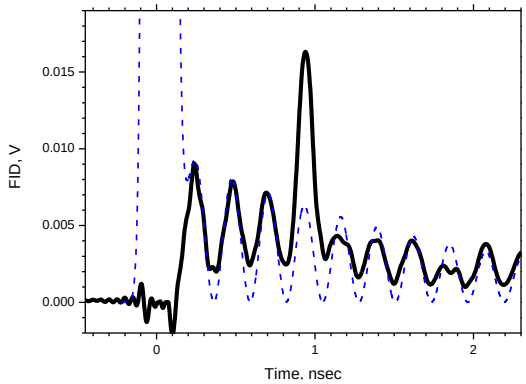

Fig. 1. Experimentally observed FID signal of OH radical. Exciting laser pulse was acc accumulated separately and subtracted. Dashed line – numeric modeling of the FID.

Absorption line of the OH radical is a Λ- doublet with a splitting of 4.3 GHz. The width of the FEL spectrum exceeds this splitting, therefore the laser simultaneously excites both components of the doublet. The FID signal contains characteristic beats with a period of 0.23 ns.

By changing delay between UV pulse and moment of measurements we can see the growing of OH concentration and at big delays decay of the OH concentration.

During the lifetime of the OH radical, many pulses of FEL pass through the cell, each of which initiates a FID signal. We could register a sequence of 10 pulses simultaneously, obtaining separate frames of the birth and death of the radical

The influence of the magnetic field on the FID signal was studied by numerical simulation. A longitudinal magnetic field leads to a rotation of the polarization plane of the signal. The angle of rotation depends on the time after the FEL pulse. The effect of a nonmonotonic rotation of the polarization was predicted - after a certain time after the pulse, the direction of rotation changes

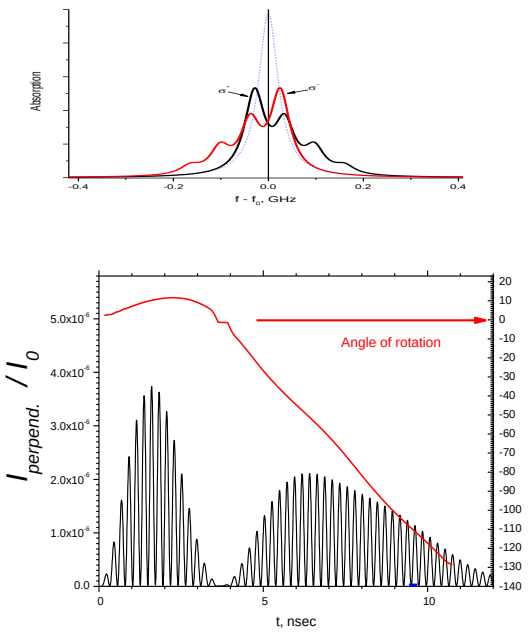

Fig. 2. Influense of magneticfield 100 G on OH spectrum (upper plot) and on FID signal. Red line shows the rotation angle of polarization plane of the FID vs.time.

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