Generation of continuum harmonic spectrum using multi-cycle two-color infrared laser fields

Eiji J. Takahashi,[1] Pengfei Lan, and Katsumi Midorikawa

Extreme Photonics Research Group, RIKEN Advanced Science Institute,
2-1 Hirosawa, Wako, Saitama 351-0198, Japan

Synopsis By mixing two infrared laser pulses of different wavelengths, we generate the continuum harmonic spectrum around a cut-off region. Our obtained harmonic spectra clearly show the possibility of generating isolated attosecond pulses from many-cylse laser pulse of the two color laser fields, 30 fs laser pulses centered at 800 nm and 1300 nm. This scheme makes it possible to easily create a high-energy attosecond pulse with a well-established conventional femtosecond laser system.

We propose and demonstrate a novel two-color scheme for generating intense isolated attosecond pulses. In this scheme, a weak multi-cycle infrared field is added to an intense 30 fs, 800 nm main driving laser field. Optimum conditions of the weak infrared pulse for generating an isolated attosecond pulse are predicted by theoretical calculation and confirmed by experiment. Figure.1 (a) shows the mixed intensity profile when a 800 nm, 30 fs pulse is mixed with a 1300 nm, 40 fs pulse. Here, the intensity ratio ($I_{1300\mathrm{nm}}/I_{800\mathrm{nm}}$) and the relative phase is fixed to be 10 % and 0 rad, respectively. As can be seen around the central peak, the amplitude of the nearest neighbors on both side are well suppressed by mixing a weak longer wavelength field. The intensity ration between the central peak and the side peak attains 0.8, which is almost the same as a ratio of 5-fs cos-wave pulse of 800 nm. Consequently, we can expect generating the continuous harmonic spectrum at the cut-off region, though many-cycle laser fields are used for the pump pulse.

To demonstrate and verify our proposed concept, we have carried out the two-color experiment by using high-energy IR sources[1] based on an OPA scheme. Figure 1 (b) shows a single shot harmonic spectrum by using the two-color laser filed. When the one-color field (800 nm: 1×10^{14} W/cm^2) is focused in Ar gas, the harmonic spectrum has a discrete structure. In the two-color scheme, we can also see a discrete harmonic spectrum at the lower order region (see the inset of Fig.1 (b)). This discrete harmonic spectrum can be treated as generation of high-order sum and difference frequencies. On the other hand, the discrete components disappear at harmonic orders higher than 29th, we can clearly see a continuum harmonic spectrum around the cut-off region. Though the spectrum at cut-off region varies slightly every laser shot because of the relative phase of two-color laser pulse is not stabilized, we were able to obtain the continuum spectrum with high probability. This scheme has an advantage to generate an isolated attosecond pulse over two-color schemes ever reported[2].

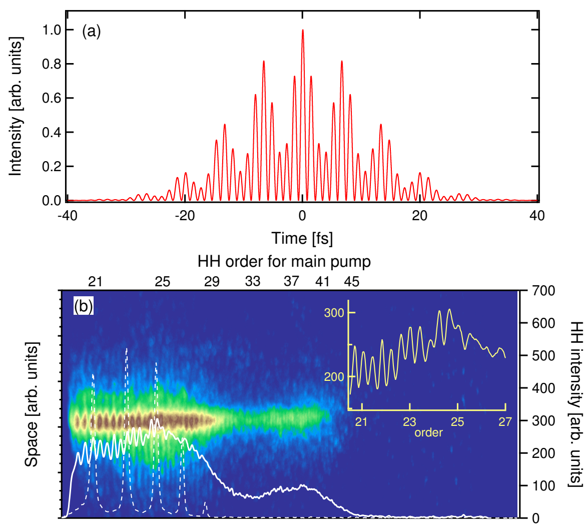

Fig. 1. (a): Temporal intensity distribution of the two-color field. (b): Single shot HH spectrum by using two-color pulse ($I_0 \sim 1.1 \times 10^{14}$ W/cm^2). The solid and dashed lines show the 1D spectrum by using two-color and one-color pulse, respectively.

References

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[1] E-mail: ejtak@riken.jp