

Research Report by T.Fukuyama

My main theme in 2013 was the electric dipole moment (EDM) of elementary particles and composite systems. EDM is very important CP violating phenomenon and sensitive to new physics. We wrote a review paper on Dec. 2012 which was welcome by world-wide experimentalists as well as theorists. Starting with the estimations of EDM of quarks-leptons in the SM, we explored new signals beyond the SM. However, these works drive us to wider frontier where we search fundamental physics using atoms and molecules and vice versa. For instance, paramagnetic atoms and molecules have great enhancement factors on electron EDM. Especially EDM of polar molecule is very promising. However, it requests hard collaboration of particle physics and chemistry since the calculation of molecular orbitals are essential for the estimation of electron EDM from the observed (or the upper limit of) molecular EDM. As the by product of this hard work I completed an another review of chiral molecule. Diamagnetic atoms and molecules are very sensitive to nuclear P and T odd processes. Thus EDM becomes the key word not only of New Physics but also of unprecedented fruitful collaboration among particle, atomic and molecular physics.

We also studied the Generalized Bargmann-Michel-Telegdi Equation, motion of spin-precession in accerelater. spin precession equation,

$$\frac{d\boldsymbol{\sigma}}{dt} = \boldsymbol{\Omega}_s \times \boldsymbol{\sigma} \quad (1)$$

where

$$\boldsymbol{\Omega}_s = -\frac{e}{m} \left[\left(G + \frac{1}{\gamma} \right) \mathbf{H} - \left(\mathbf{G} + \frac{\mathbf{1}}{\gamma + \mathbf{1}} \right) \mathbf{v} \times \mathbf{E} + \frac{\mathbf{d}}{2} (\mathbf{v} \times \mathbf{H} + \mathbf{E}) \right]. \quad (2)$$

However, to be curious enough, the explicit derivation of this equation has not been published. This equation was the conjecture under the assumption of the duality of \mathbf{B} and \mathbf{E} .