Particle Acceleration by Stimulated Emission of Radiation (PASER)

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1. Motivation

Nowadays, electrons are accelerated to high energies by their passage through cavities that store electromagnetic energy. Each cavity is of a few cm's length containing about $5 \times 10^{24}$ photons.

Question:
can we accelerate electrons using energy stored in individual atoms or molecules?

![Image: 400 cells, each of 1cm long]

2. Historical Context

- **a) Franck-Hertz Exp.**: Energy transferred from a free electron to a bound electron – deceleration.
- **b) LL Exp.**: Inverse Franck-Hertz – acceleration.
- **c) LASER**: Multiple collisions of a wave with atoms.
- **d) PASER**: Inverse LASER, coherent collisions of the 2nd kind – acceleration.

3. Experimental Setup

- 45MeV-5psec electron beam is modulated in a wiggler by interacting with 0.5GW-200psec CO$_2$ laser pulse.
- The bunch enters an active medium – its resonant frequency is identical to that of the train of microbunches.
- The bunch is monitored both when the discharge circuit is on and when it is off.

4. Experimental Results

![Graph: Discharge off to Discharge on]

- ~685keV energy gain
- ~845keV energy gain
- 200keV energy gain
- ~2,000,000 collisions of the second kind between the acc. electron and the excited molecules of the CO$_2$ mixture