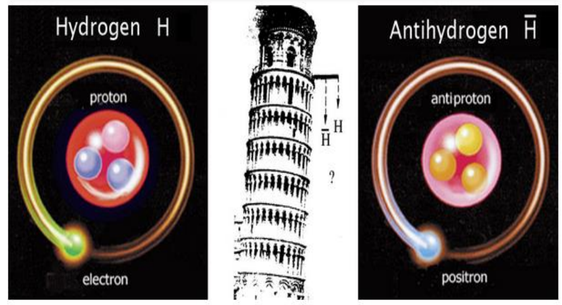
No. **SPS15**

Investigation of Sympathetic Laser Cooling of $\bar{p}$ in Paul trap

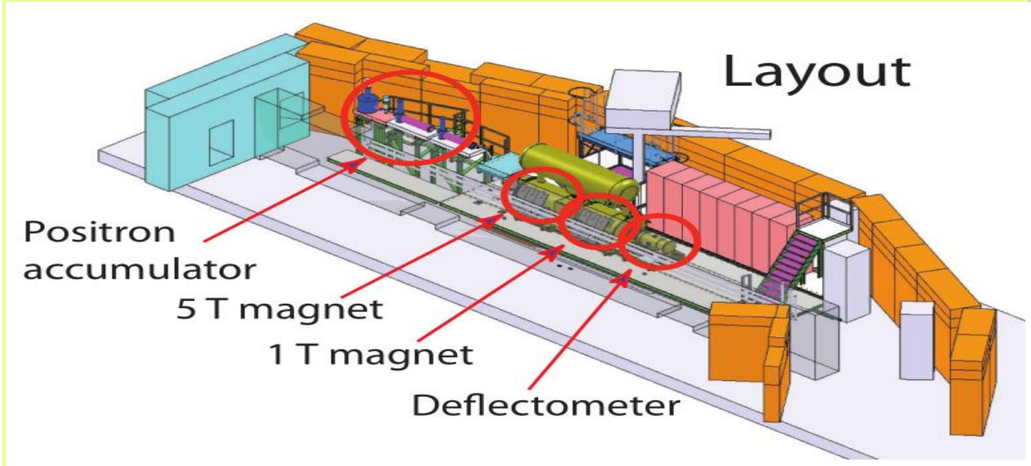
Home Institute: Sun Yat-Sen University; School of Physics and Engineering(SPE)

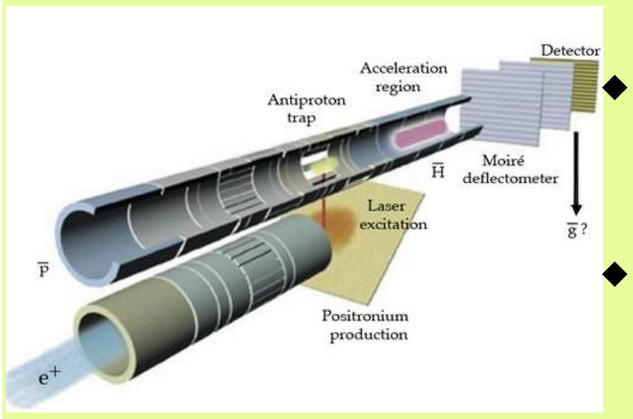
Supervisor: Michael Doser (CERN; AEgIS)

Lu Wang 汪璐



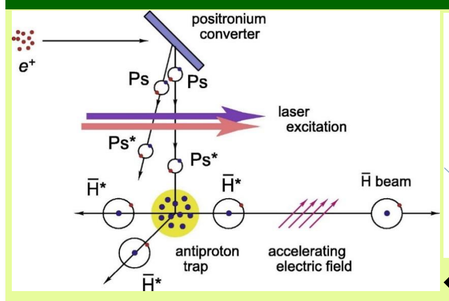
Introduction to AEgIS experiment

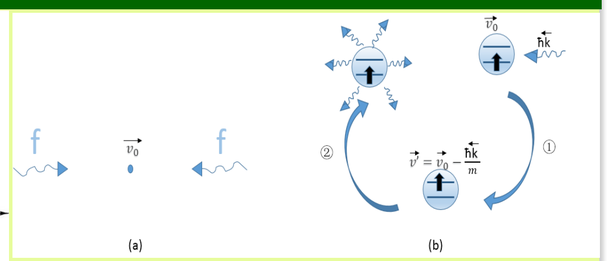




- Reach an accuracy of 1% in the measurement of the matter-antimatter gravitational acceleration.[1]
- Test for CPT violation by S1-S2 transition frequency of the antihydrogen.[1]

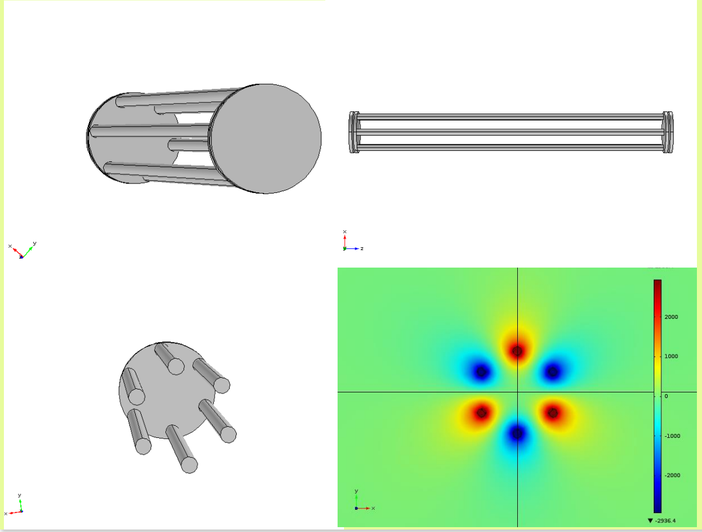
Formation of the $\overline{H}$ & Working principle of the laser system





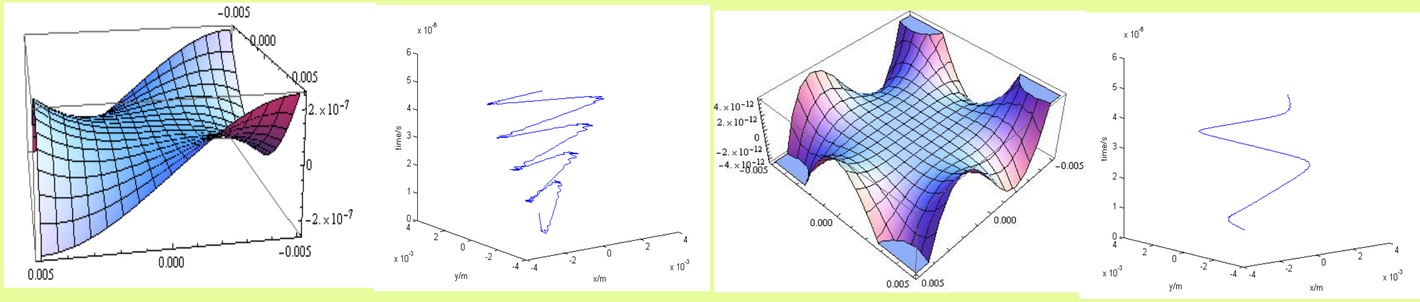
- Atom→ 2-level system
- Spontaneous emission→ F=- βv [2]

Geometry of the Paul trap



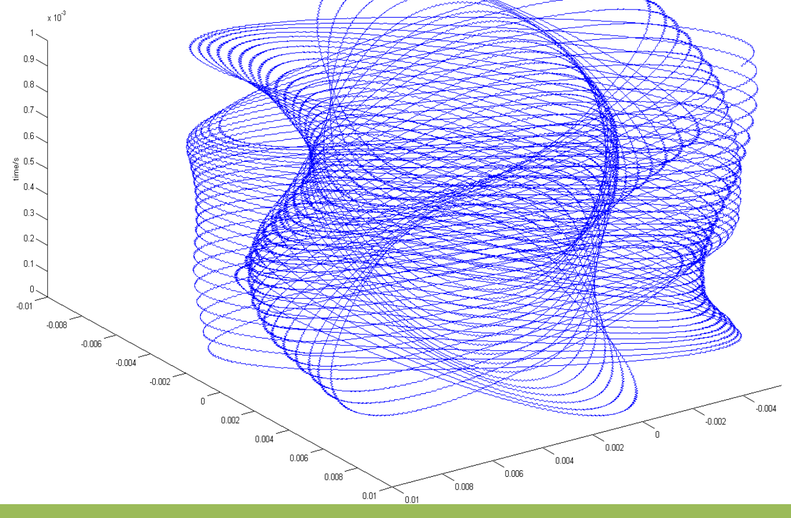
Item	value	Unit
f	8E+7	Hz
V_0	10	V
r_0	5E-3	m
L	3E-2	m
β	E-20	Kg/s

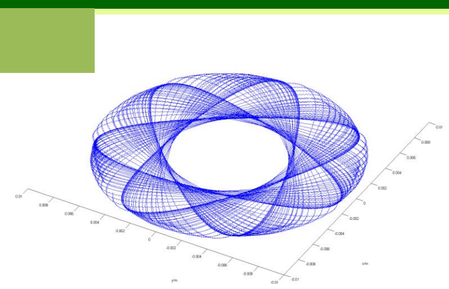
Electric Potential inside the trap: $V = \frac{V_0 Sin(wt)\cos(n\varphi)r^n}{{r_0}^n} = \frac{V_0 Sin(wt)}{{r_0}^n} X(\mathrm{r},\varphi)$



Motion of the antiproton in the Paul trap (with and without the buffer gas)

Without buffer gas



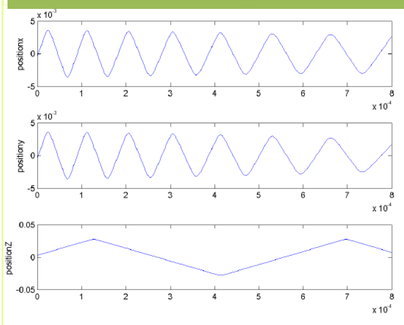


$$F_{buffer} = F_{Electric.field} + F_{coulomb} + F_{laser}$$

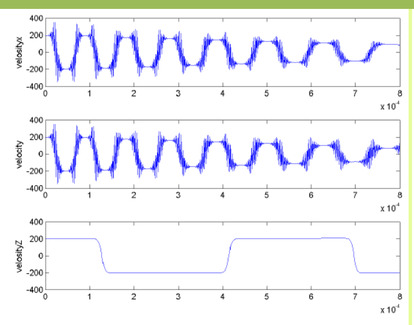
$$F_{p\_bar} = F_{Electric.field} + F_{coulomb}$$

Initial Temperature T=4K

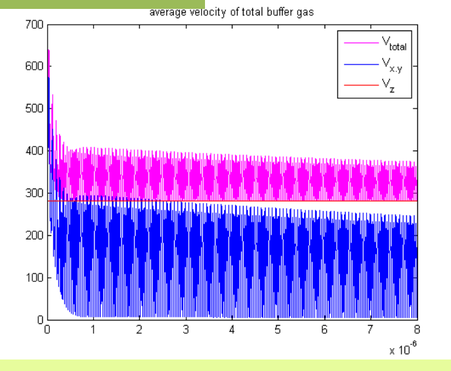
With buffer gas



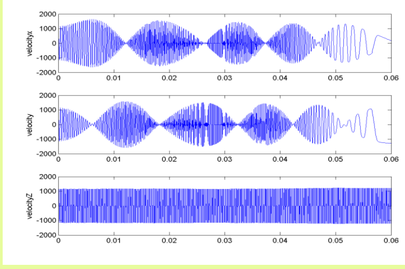
(a) position of antiproton

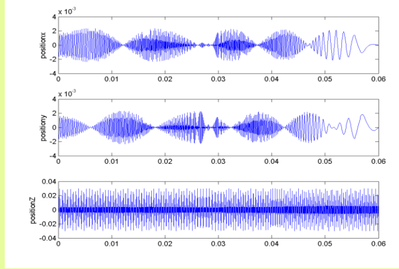


(b) velocity of antiproton



Modification of the simulation code----remove the micro motion of the antiproton





$$m(\ddot{x}_{secular} + \ddot{x}_{micro}) = -\frac{qV_0 Sin(wt)}{{r_0}^n}\nabla X(x_{secular} + x_{micro}) + F_{laser} + F_{coulomb}$$

$$m\ddot{x}_{secular} = -\frac{q^2 {V_0}^2}{2mw^2 {r_0}^{2n}}\nabla r^{2n-2} + F_{laser} + F_{coulomb}$$

References

[1]G.Dobrychev , P.Nedelec , D.Sillou , et al: Proposal for the AEGIS (Antimatter Experiment: Gravity, Interferometry Spectroscopy). In: CERN-SPSC(2007), S.334-459

[2] A.Ostendorf ,CB.Zhang , MA.Wilson ,et al: Sympathetic cooling of complex molecular ions to millikelvin temperatures. In: Physical review letters 97(2006), Nr.24, S. 243005

Contact： lu.wangphysics@gmail.com

Telephone: +86 13570428027