

Week 1

High Field Science

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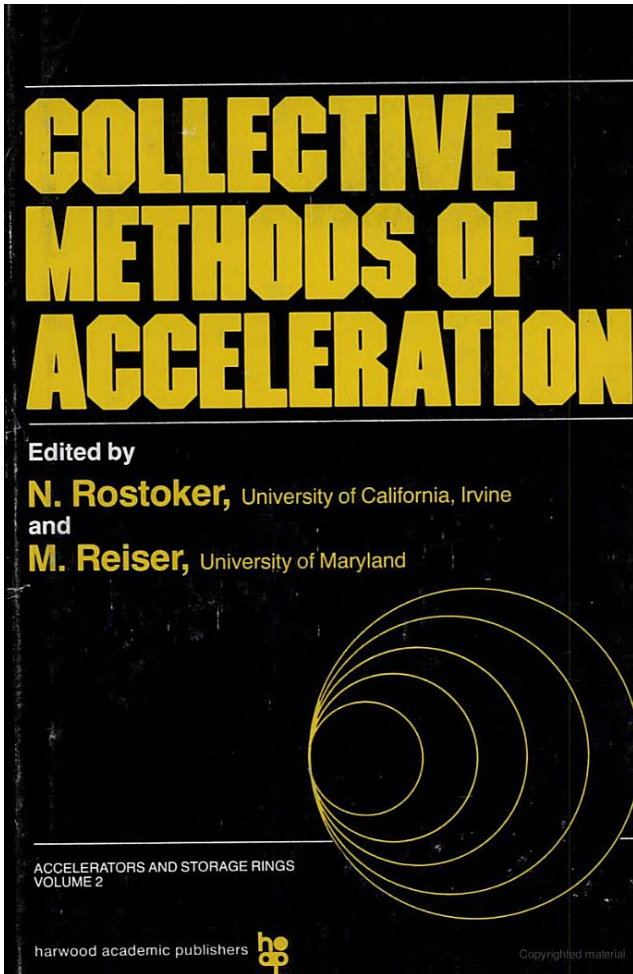
UCI

PHY249

Introduction: High Field Science

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(1979)



Proud UCI tradition

collective acceleration 40 years ago



A salmon heading up for its old nest

Home of Pioneering Research UCI

Accelerator physics x *Plasma Physics*

Norman Rostoker's legacies:

Fusion plasma
by *accelerator approach*

Accelerators
by *plasma physics*



scope of this course

Incubation period: Collective Accelerators (1973-75)



Professor N. Rostoker

Collective acceleration suggested:

Veksler (1956)

(ion energy) ~ (M/m)(electron energy)

Many experimental attempts (~'70s):

“Collective accelerators” (Rostoker/Reiser, 1979)

led to no such amplification

(ion energy) ~ (several)x(electron)

Mako-Tajima analysis (1978;1984)

sudden acceleration, ions untrapped,
electrons return, while some run away

→ #1 **gradual acceleration necessary**

→ #2 **electron acceleration possible**

with **trapping** (with Tajima-Dawson
field),

more tolerant for sudden process

→ #3 laser ion acceleration (3 decades later)

similar to **Rostoker's experiments**

Collective ion acceleration by a reflexing electron beam: Model and scaling

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Analytical and numerical calculations are presented for a reflexing electron beam type of collective ion accelerator. These results are then compared to those obtained through experiment. By constraining one free parameter to experimental conditions, the self-similar solution of the ion energy distribution agrees closely with the experimental distribution. Hence the reflexing beam model appears to be a valid model for explaining the experimental data. Simulation shows in addition to the agreement with the experimental ion distribution that synchronization between accelerated ions and electric field is phase unstable. This instability seems to further restrict the maximum ion energy to several times the electron energy.

I. INTRODUCTION

Experiments on collectively accelerating ions utilizing a reflexing intense relativistic electron beam in a plasma have been carried out.^{1,2} These experiments began to reveal sever-

chronous fashion. Thus, energetic ions would be expected. The ion energy would, of course, be bounded above by the ion to electron mass ratio times the initial electron energy; that is, the energy is bounded when the ions reach the initial