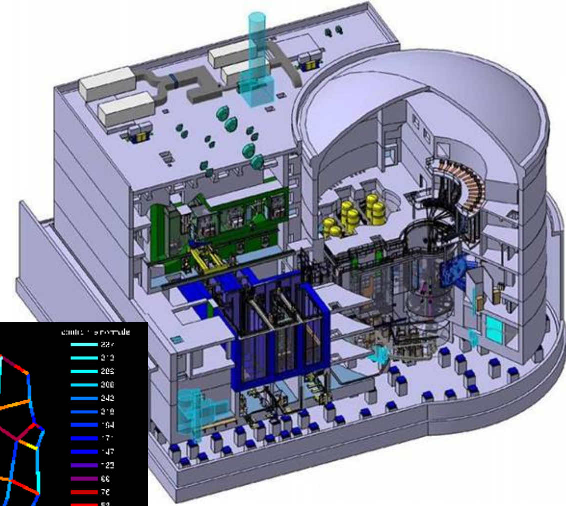
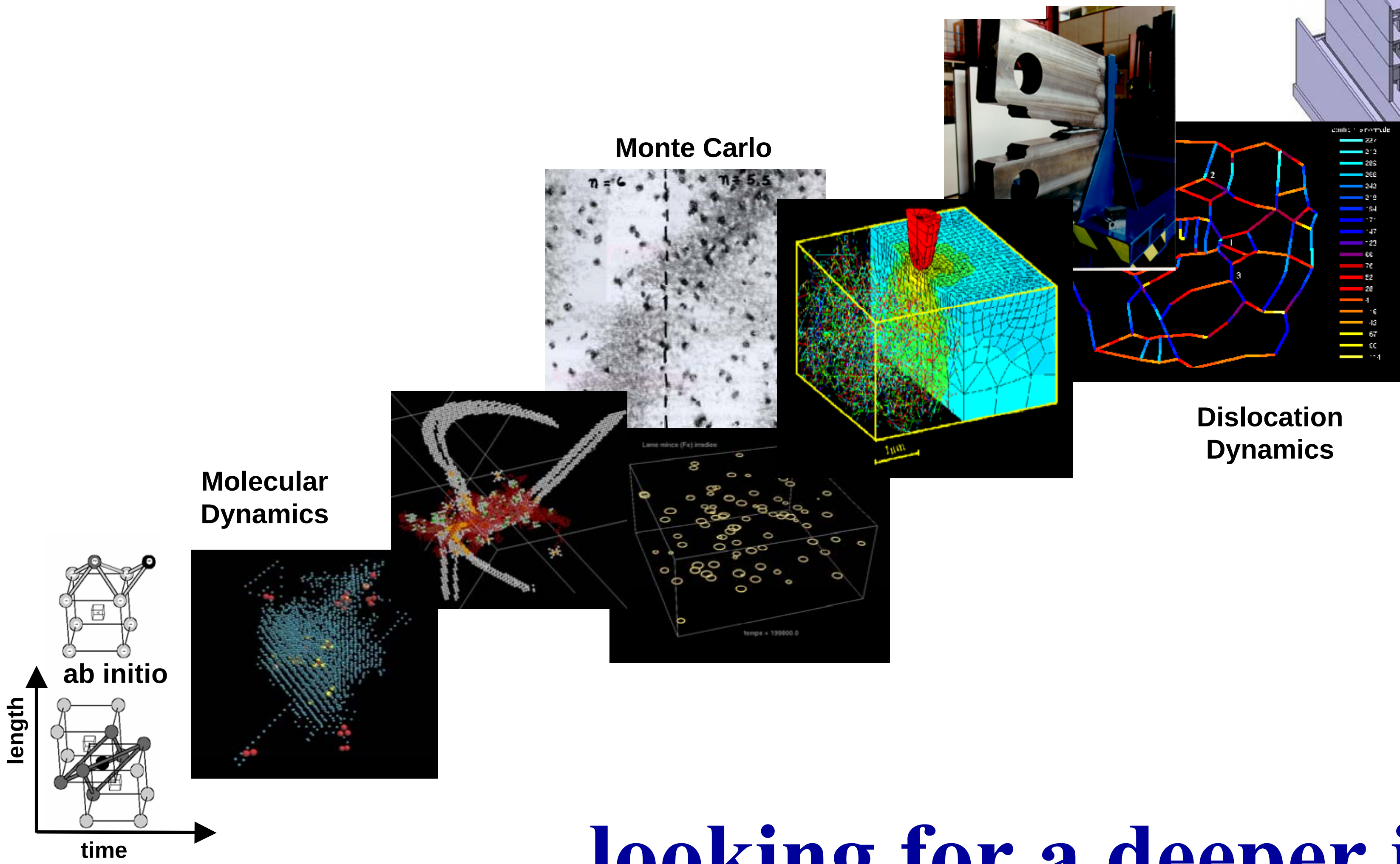
A unique experience : from Theory to Applied Science

D. Iracane & P. Chaix

Addressing new topics …





… looking for a deeper insight & getting into the machinery

An ambitious program

- 1981: nucleon-nucleon interaction, looking for a deeper insight justification from Quantum Chromodynamics

- Using a powerful tool : variational methods and mean field theory

- An intricate topic with severe issues,
  - ✓ gauge invariance, renormalisation …

- But interesting results

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July 1983

SIMPLE MODEL FOR THE QCD VACUUM

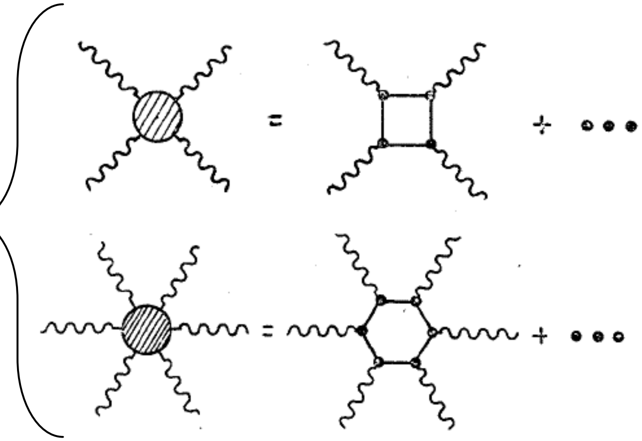
Michael Danos

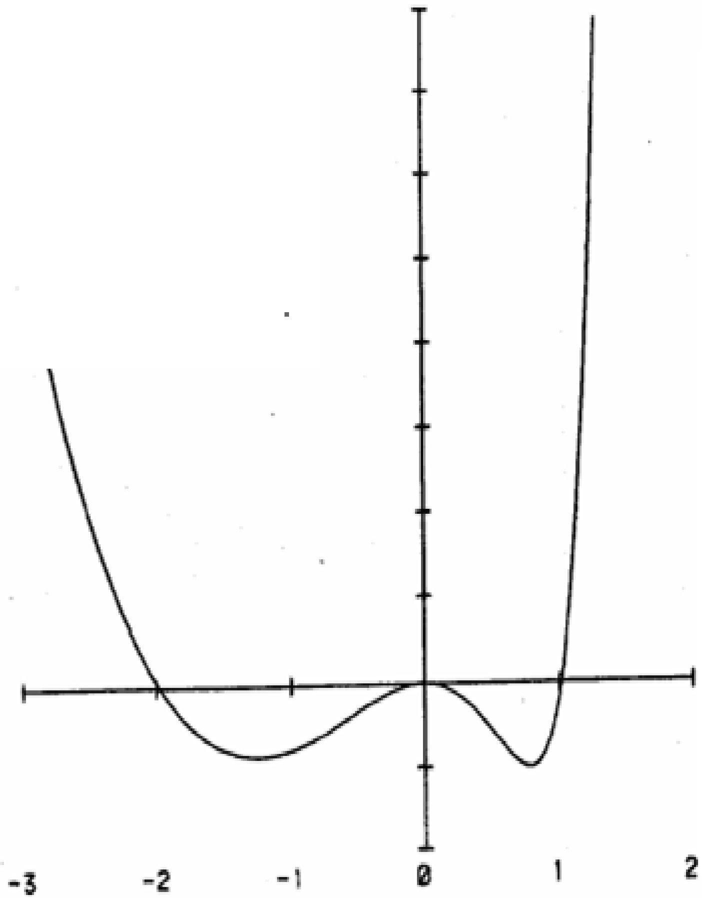
U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Radiation Research
Washington, DC 20234

Daniel Gogny and Daniel Irakane

Centre d'Etudes de Bruyeres-le-Chatel
92542 Montrouge
CEDEX, France

Looking for an attractive channel, the effective force, a tricky point





Gluon condensate study within Bogoliubov mean field theory:

Mathematical, then numerical analysis exhibit a competition between 2 phases

-a supra-conducting condensate with a non-zero gap (→ mass)

-a Bose-Einstein condensate

Addressing more “useful” topics ...

- Getting deeper insight Relativistic mean field theory

- In a domain

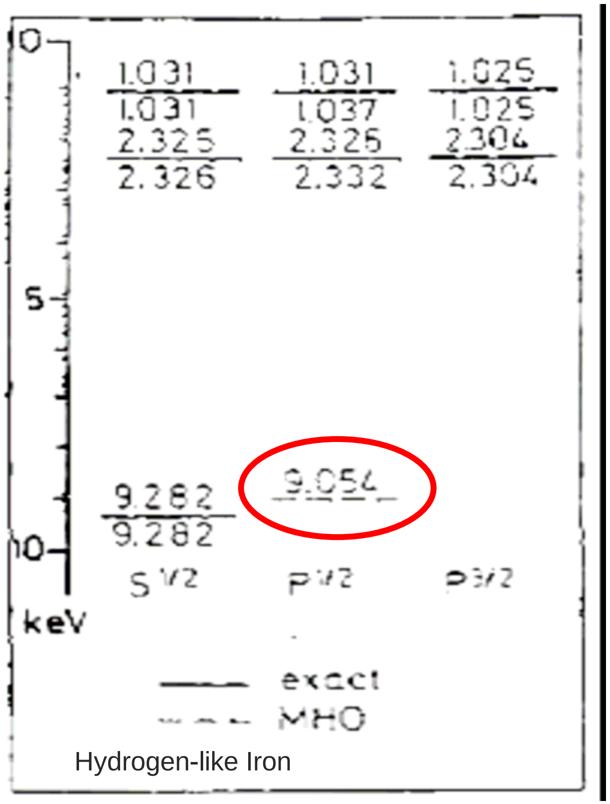
  where forces are well known

  with “clear operational stakes (1987...)“

COMPUTATION

OF HEAVY IONS/ATOMS

From relativistic atomic calculations...



Hydrogen-like Iron

From Density Functional method to basis expansion methods

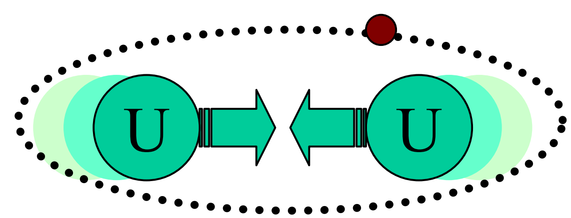
Spurious eigenstates of the one-body Dirac Hamiltonian

The Dirac Hamiltonian with Coulomb interaction is not bounded from below

-How to project out spurious state

-How to define the Fermi level with negative energy states (Z > 137 = 1/α)?

e.g.:



… back to fundamental issues

J. Phys. B: At. Mol. Opt. Phys. **22** (1989) 3791-3814. Printed in the UK

J. Phys. B: At. Mol. Opt. Phys. **22** (1989) 3815-3828. Printed in the UK

From quantum electrodynamics to mean-field theory:

I. The Bogoliubov–Dirac–Fock formalism P Chaix and D Iracane

II. Variational stability of the vacuum of quantum electrodynamics in the mean-field approximation P Chaix , D Iracane and P L Lions

What is the vacuum of QED for relativistic variational calculations of atoms?

Minimisation of energy in a Bogoliubov-Dirac-Fock variational space
Self-consistent Projection !

The QED vacuum is not stable if $\alpha > 4/\pi$
The BDF QED vacuum is stable if $\alpha < 4/\pi$
($\alpha = 1/137 < 4/\pi$, by chance …)

Meanwhile, the SDIO in USA ...

Large power FEL

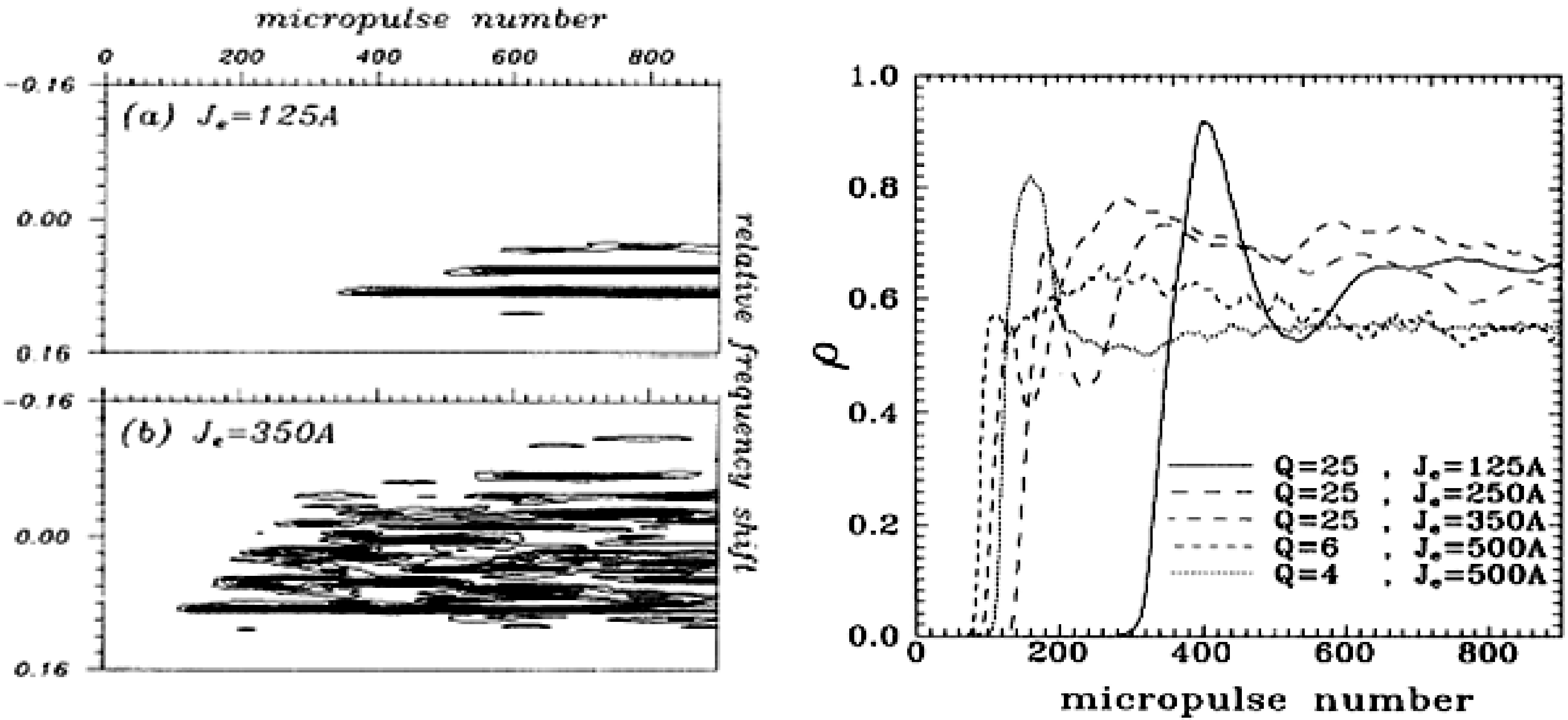
operational capacities for Defence applications

?

VOLUME 66, NUMBER 1 PHYSICAL REVIEW LETTERS 7 JANUARY 1991

Stability of a Free-Electron-Laser Spectrum in the Continuous-Beam Limit

D. Iracane and J. L. Ferrer
Commissariat à l'Energie Atomique, B.P. No. 12, 91680 Bruyeres-Le-Chatel, France
(Received 9 July 1990)



VOLUME 67, NUMBER 22 PHYSICAL REVIEW LETTERS 25 NOVEMBER 1991

Two-Frequency Wiggler for Better Control of Free-Electron-Laser Dynamics

D. Iracane and P. Bamas

PHYSICAL REVIEW E VOLUME 48, NUMBER 5 NOVEMBER 1993

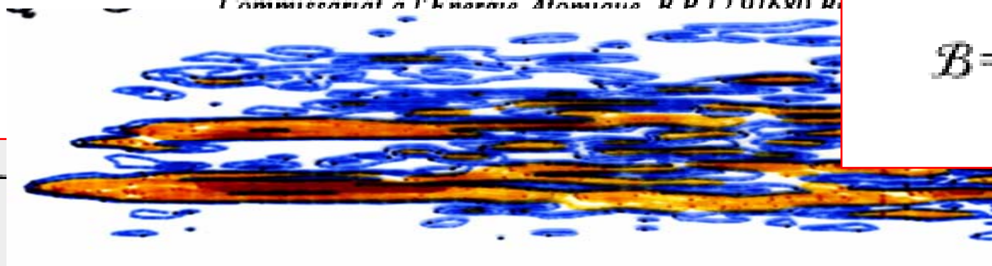
Stochastic electronic motion and high-efficiency free-electron lasers

P. Chaix, D. Iracane, and C. Benoist

VOLUME 72, NUMBER 25 PHYSICAL REVIEW LETTERS 20 JUNE 1994

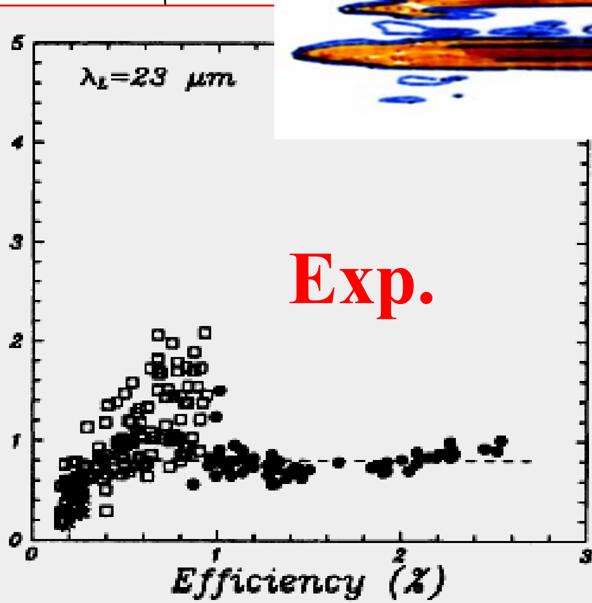
Experimental Evidence for High-Efficiency, Low-Brightness Behavior in Free-Electron Lasers

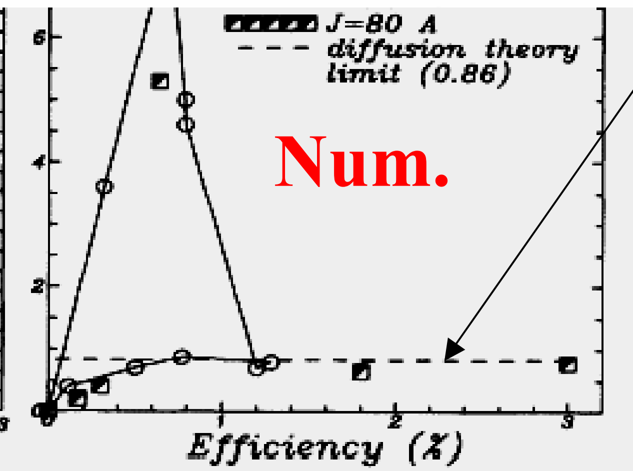
D. Iracane, V. Fontenay, P. Guimbal, S. Joly, S. Striby, and D. Touati



Theory

$$\mathcal{B} = \frac{E_L}{QE_e\Sigma} \le \mathcal{B}_M = \frac{\sqrt{3}}{2} \simeq 0.86 ,$$





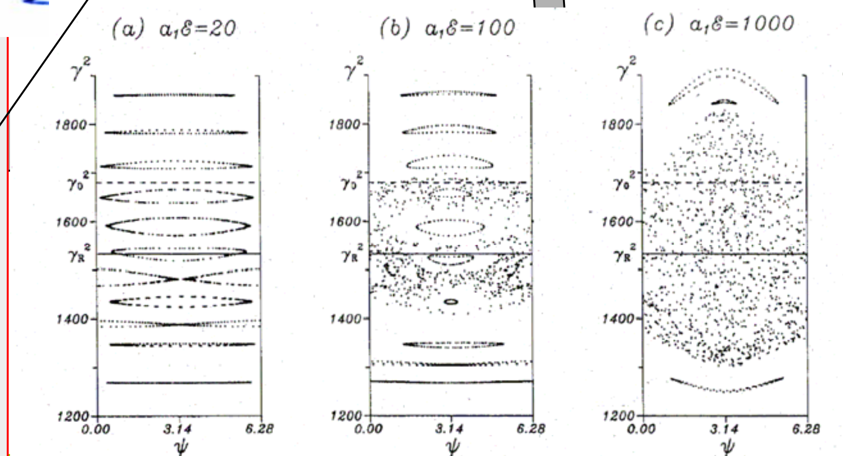


Fig. 2. Poincaré sections of the electronic phase space in a TFW for a monochromatic laser field, for increasing values of the intenstiy.

A part of the heritage:
How to identify the most important texts