Recent Nuclear Theory Activities at the KFKI RMKI

- Tradition &
  Names
- Grops &
  Topics

Tradition and Names

Topical spectrum: nuclear, particle, gravity, math in close connection

Kuti, Hasenfratz, Montvay, Polónyi, Szlachányi: lattice QCD, QGP

Lukács, Montvay, Zimányi: QGP, hydro, thermo

Zimányi, Bencze, Révai, Doleschall: quantum nuclear

Zimányi School: Csernai, Biró, Lévai,

Groups and Topics

Thermodynamics: Biró, Ván, Molnár, Ürmössy

Fundamental questions: relativity, dissipation, stability, causality,

Non-extensive systems: hadronization, spectra, fluctuating environment (superstatistics MCarlo)

Phenomenological models: quark

Groups and Topics

Hydrodynamics: Csernai, Csörgő, (Csanád), Nagy, Vértesi

Computer solutions

Analytic solutions

Eta mass / chiral symmetry restoration

Pion laser

Groups and Topics

Hydrodynamics: Lévai, Barnaföldi, Kalmár, Pochybova, Hamar, ...

pQCD caluclation**, jets**, partons

Fragmentation vs recombination,

ALCOR

Numerical simulation of plasma and strong fields

Groups and Topics

Hadrodynamics: Wolf, Zetenyi, Kovacs, ...

Effective field theory models

Resonances in dense hadronic matter

Photon and dilepton production example

Elementary classical problems with fields

Close connection to: **FAIR**

Example: Thermal looking spectra from classical fields

Recent work by Biro [RMKI], Schram [Debrecen], Gyulassy [RMKI and Columbia]

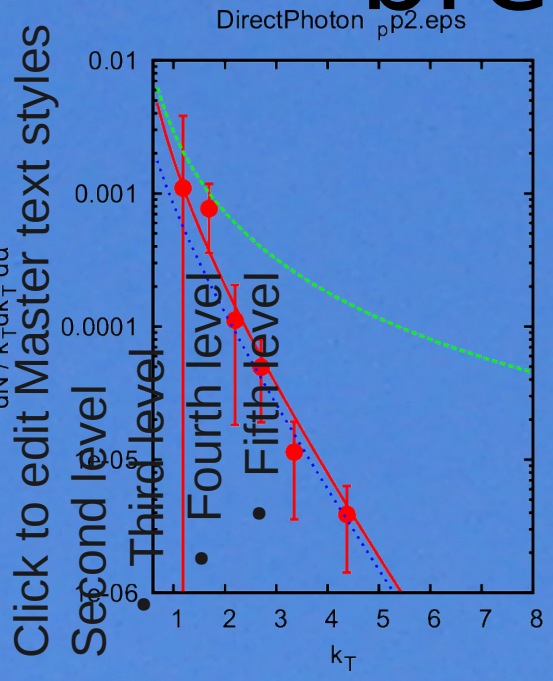
Semiclassical bremsstrahlung

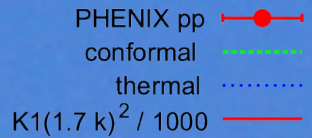
Point charge with constant acceleration

Analytically solvable non-constant acceleration

Generalization to the radiation of

Soft classical bremsstrahlung





Transverse flow interpretation ?

Mathematica knows: (I derived it using Feynm

variables)

Alike Jüttner distributions integrated over the flow rapidity…

The reverse problem

Photon spectrum ⇒ amplitude

Amplitude ⇒ Fourier component

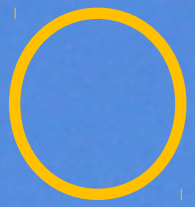
Phase ⇒ velocity

Velocity ⇒ rapidity

Rapidity ⇒ acceleration

Acceleration ⇒ Path x (t)

Analytic results



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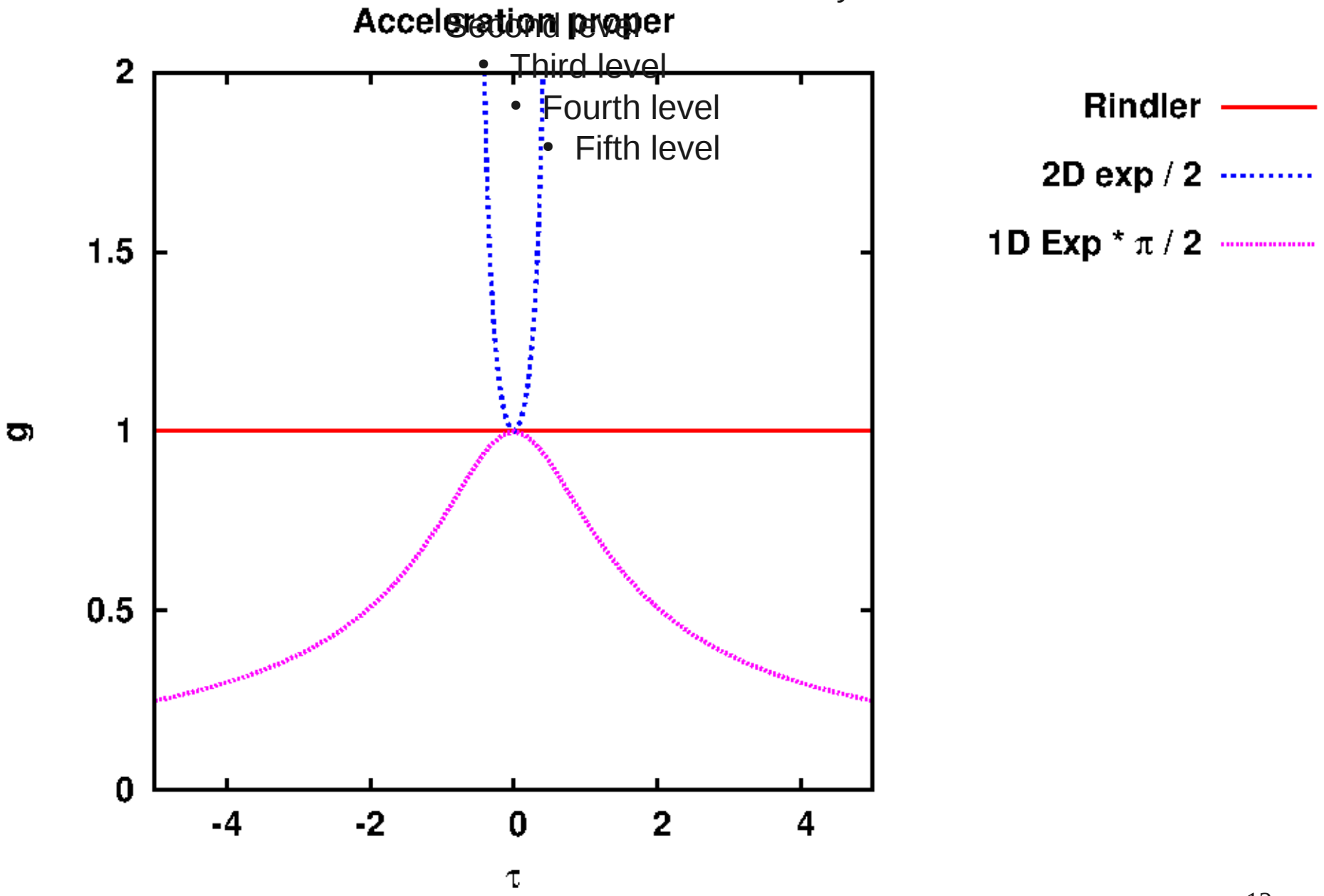

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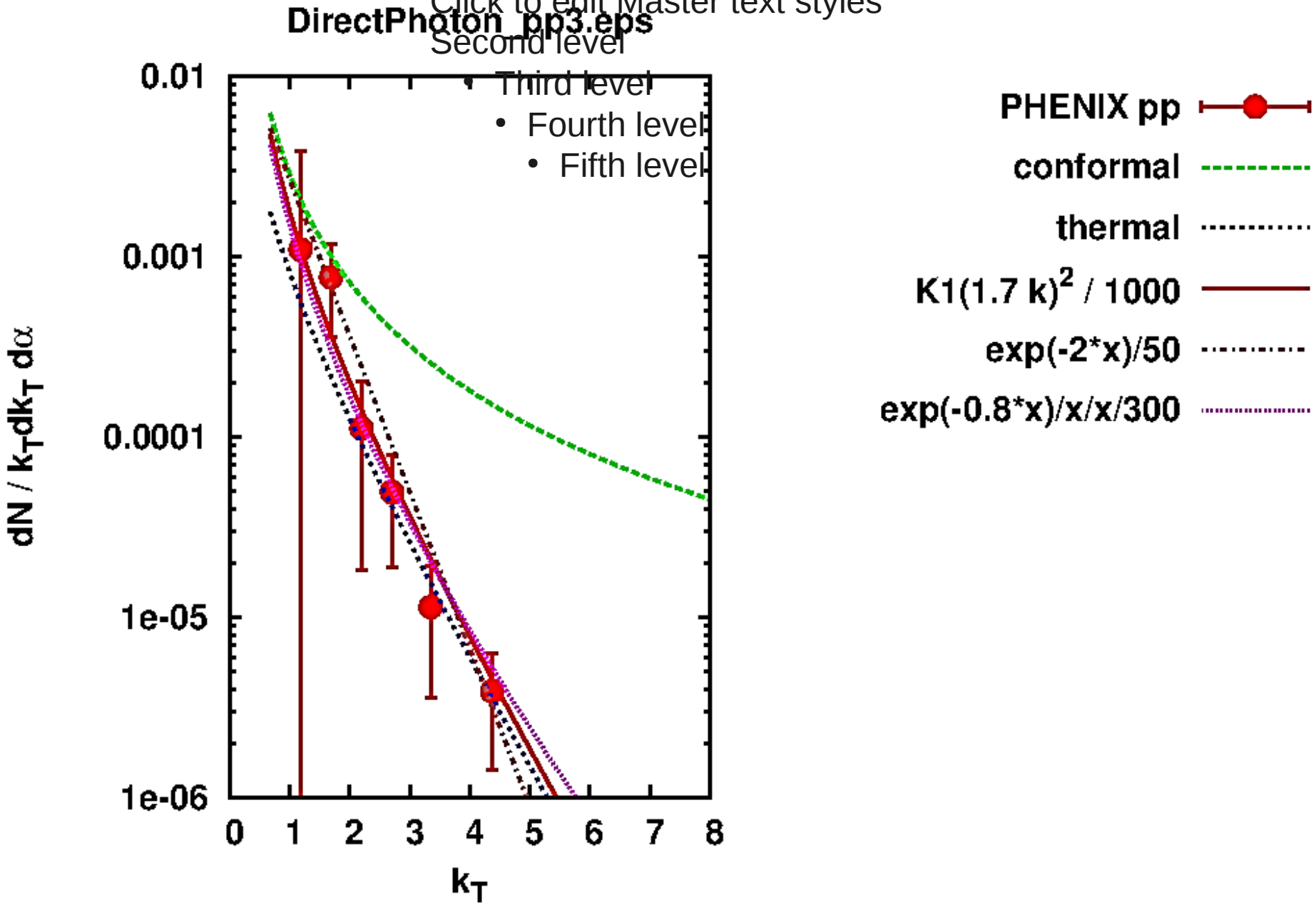
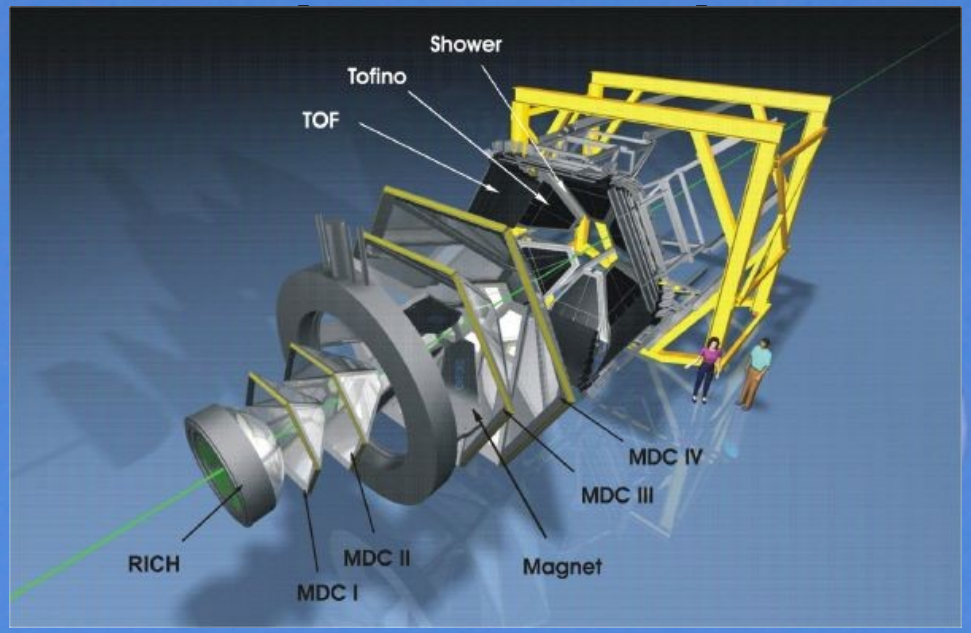


Bessel-K compendium

3 ▯ 1 : expand Dirac delta as Fourier integral,
3 ▯ 2 : rewrite integral over difference and the sum bx = x1 + x2

Dilepton production in collisions



HADES detector @ GSI

- measure electron-positron pair spectra in heavy-ion and elementary collisions

Dileptons (electron-positron pairs) do not participate in strong interaction
→ they leave the dense phase unchanged

Neutral vector mesons ($\rho 0$, ω) decay directly to e^+e^-
→ their spectral function can be studied on the dilepton spectrum

Calculation of dilepton spectra

H W Barz, B Kämpfer, Gy Wolf, M Zétényi, Open Nucl. & Part. Phys. Journal 3 (2010) 1.

Boltzmann-Uhling-Uhlenbeck (BUU) type transport model

- solve a Boltzmann-like equation using test particles

- dilepton sources:
  - Bremsstrahlung, $NN \rightarrow NNe^+e^-$
  - vectormeson decays, e.g. $\rho \rightarrow e^+e^-$
  - Dalitz-decays of baryon resonances, $R \rightarrow Ne^+e^-$

Off-shell transport

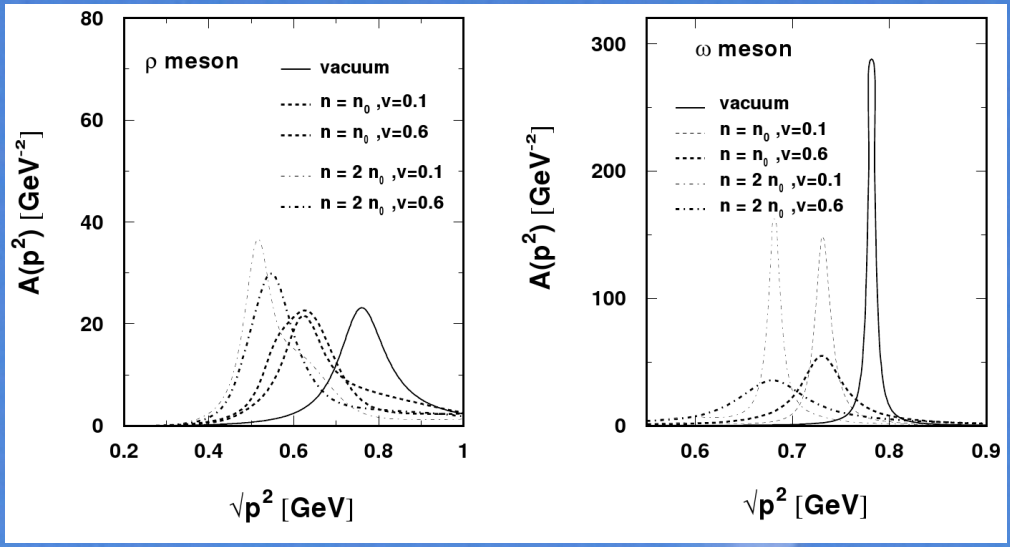
mesons, e.g. $\eta \rightarrow ye^+e^-$

- take into account the modification of particle properties in the medium

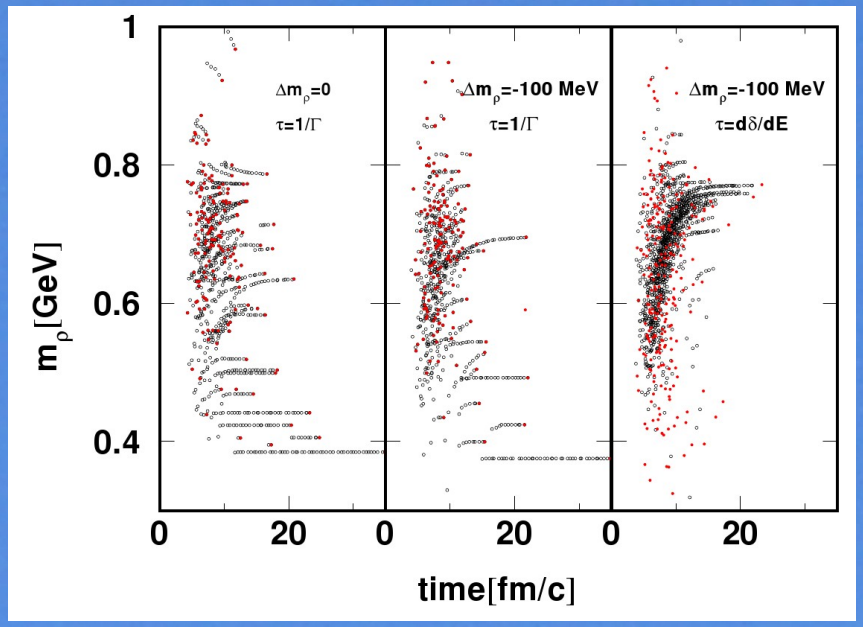
$\rightarrow$ the particle mass can change during propagation

$$\frac{dm^2}{dt} = \frac{1}{1-C}\left(\frac{d}{dt}Re\Sigma^{ret} + \frac{m^2 - m_0^2 - Re\Sigma^{ret}}{\hat{\Gamma}}\frac{d}{dt}\hat{\Gamma}\right)$$

Vector meson spectral functions in the medium



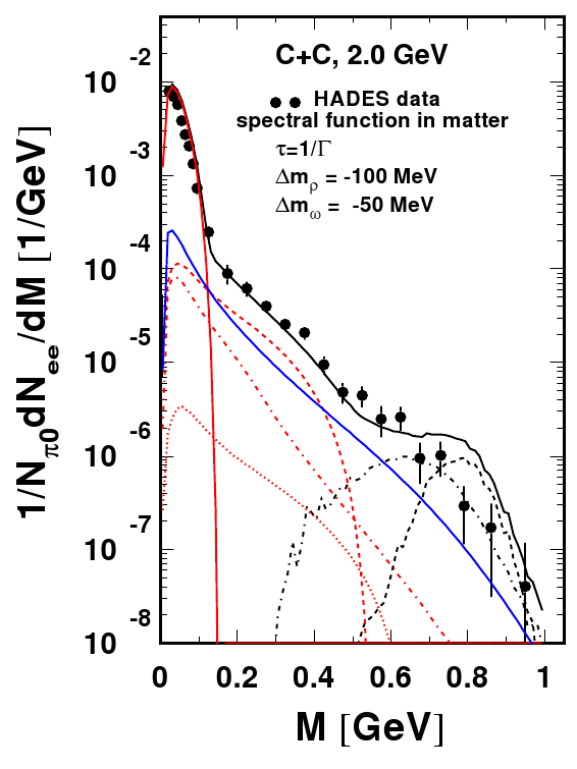
Change of test particle mass during propagation (ρ meson; C+C, 2 A GeV)



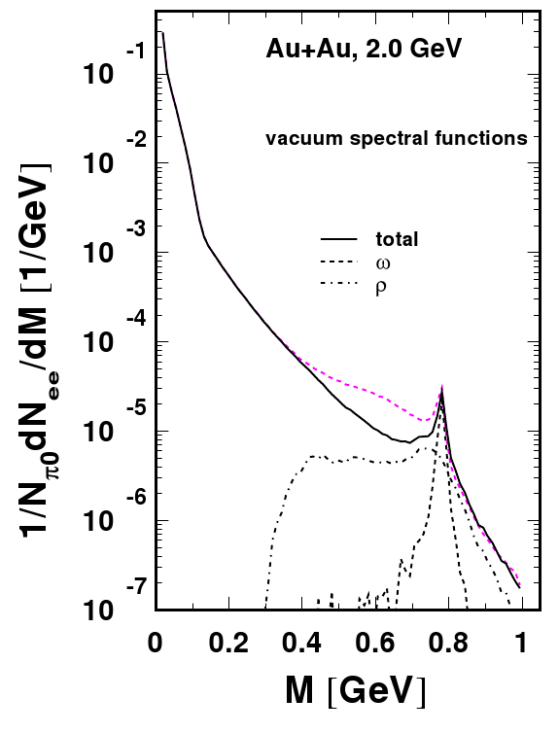
- different prescriptions for the in-medium ρ mass shift
- different prescriptions for the lifetime, τ
- red circle: ρ meson absorbed, or decaying

Resulting di-electron spectra

Comparison to experimental data



Significance of in-medium effects



black curve: vacuum spectral function
violet curve: in-medium spectral function

Statistics

Researchers: age distribution, qualifications

Support: basic vs project

Publication: journals and impacts

Visibility: citations, invitations, teaching, public appearences, awards and honors

Committee work: MTA, OTKA, RMKI TT and directorship, EPJ SAC, NUPECC, EPJA

Organization: HCBM 2010, Zimanyi School, IAC memberships in SigmaPhi, SQM, QM…

Distribution of scientific degrees

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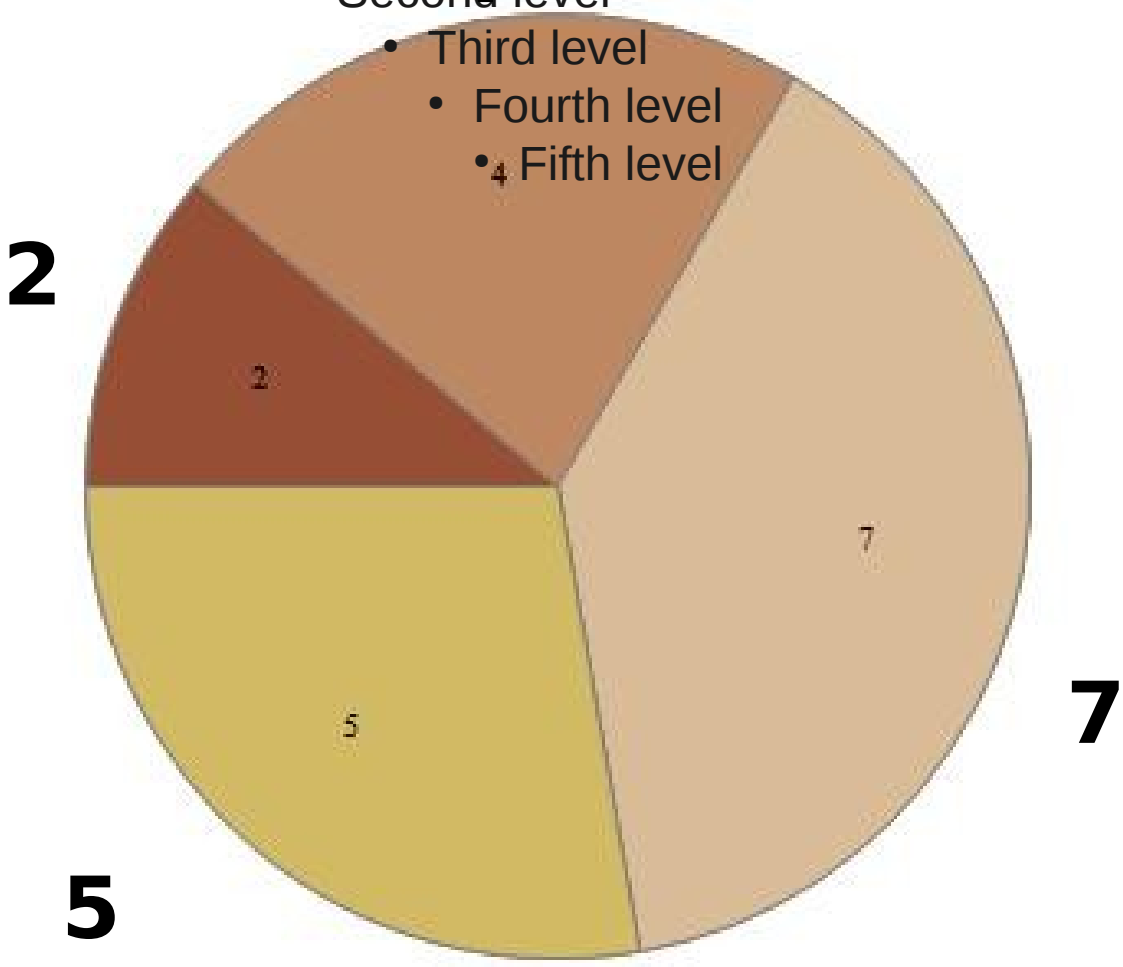

Distribution of WoS topics

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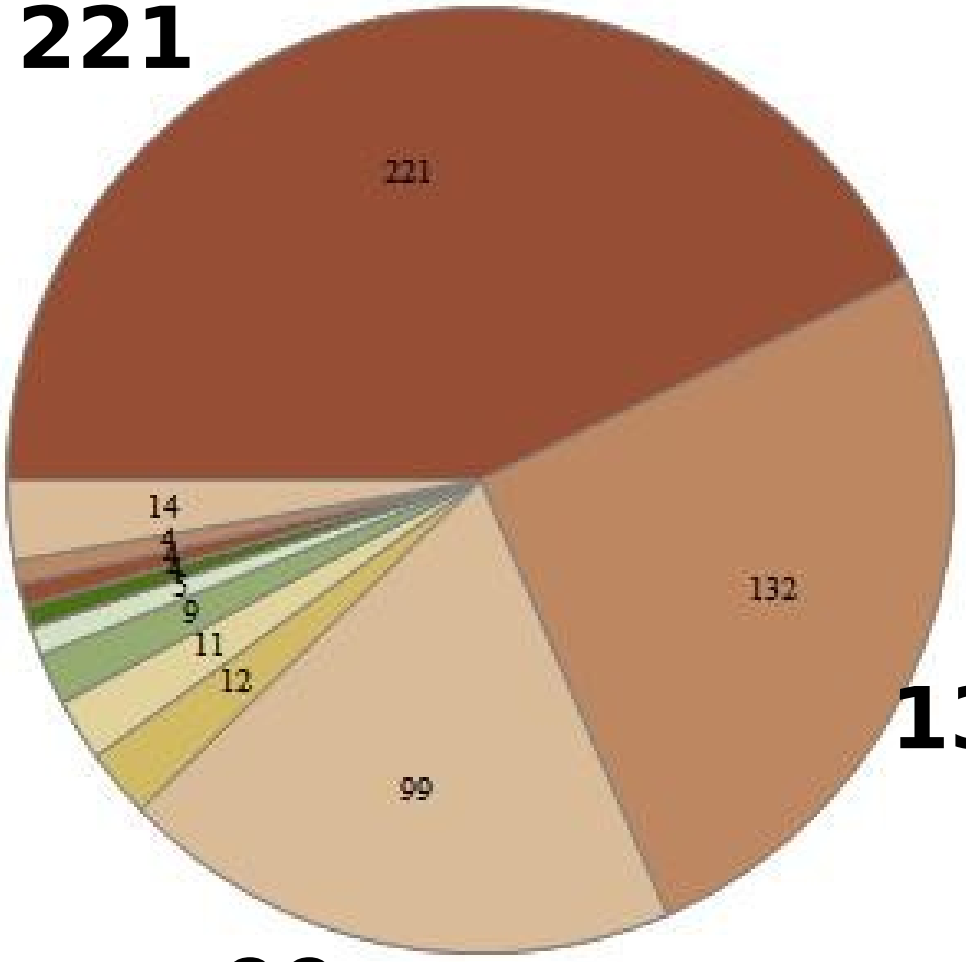

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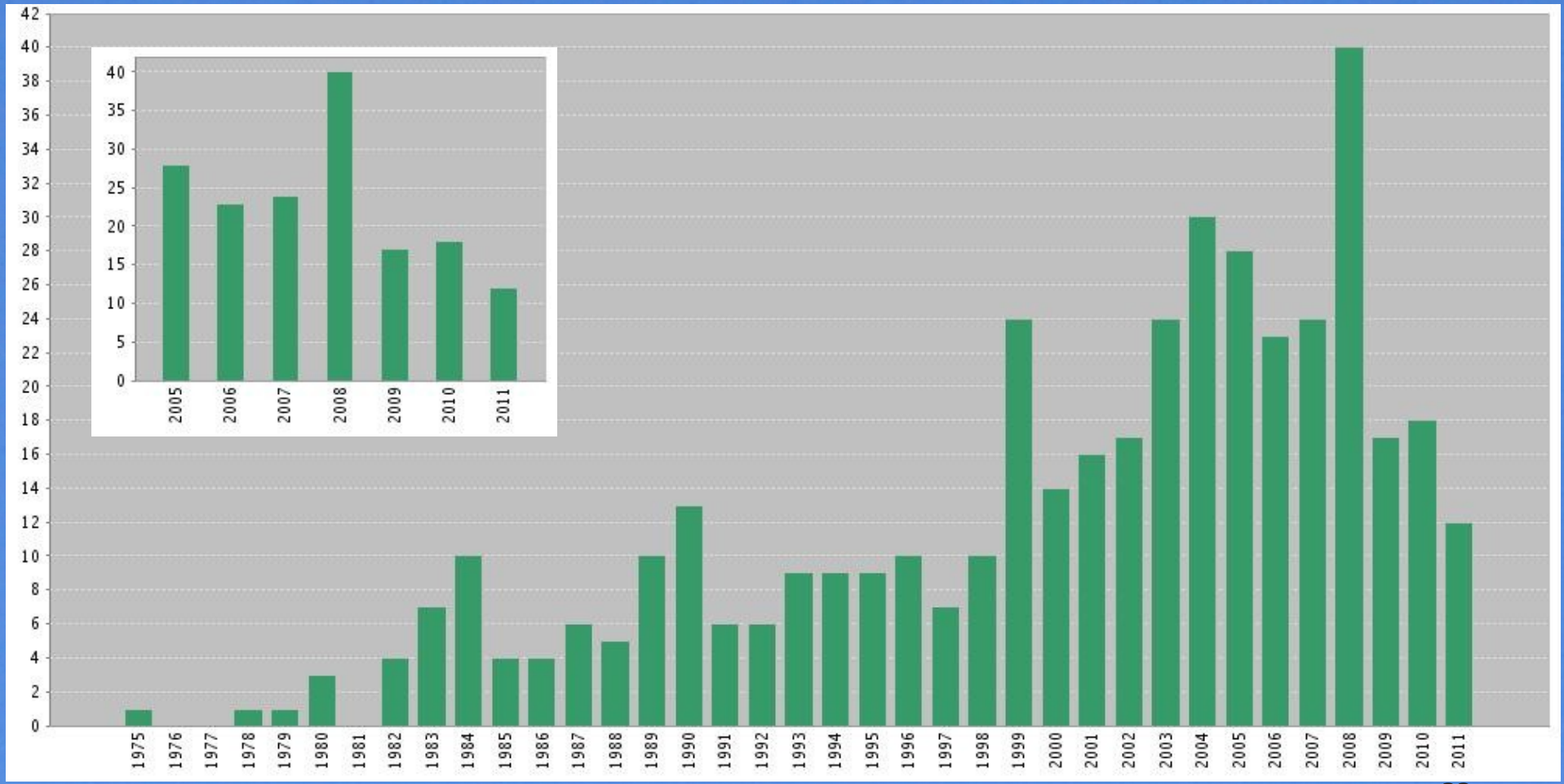
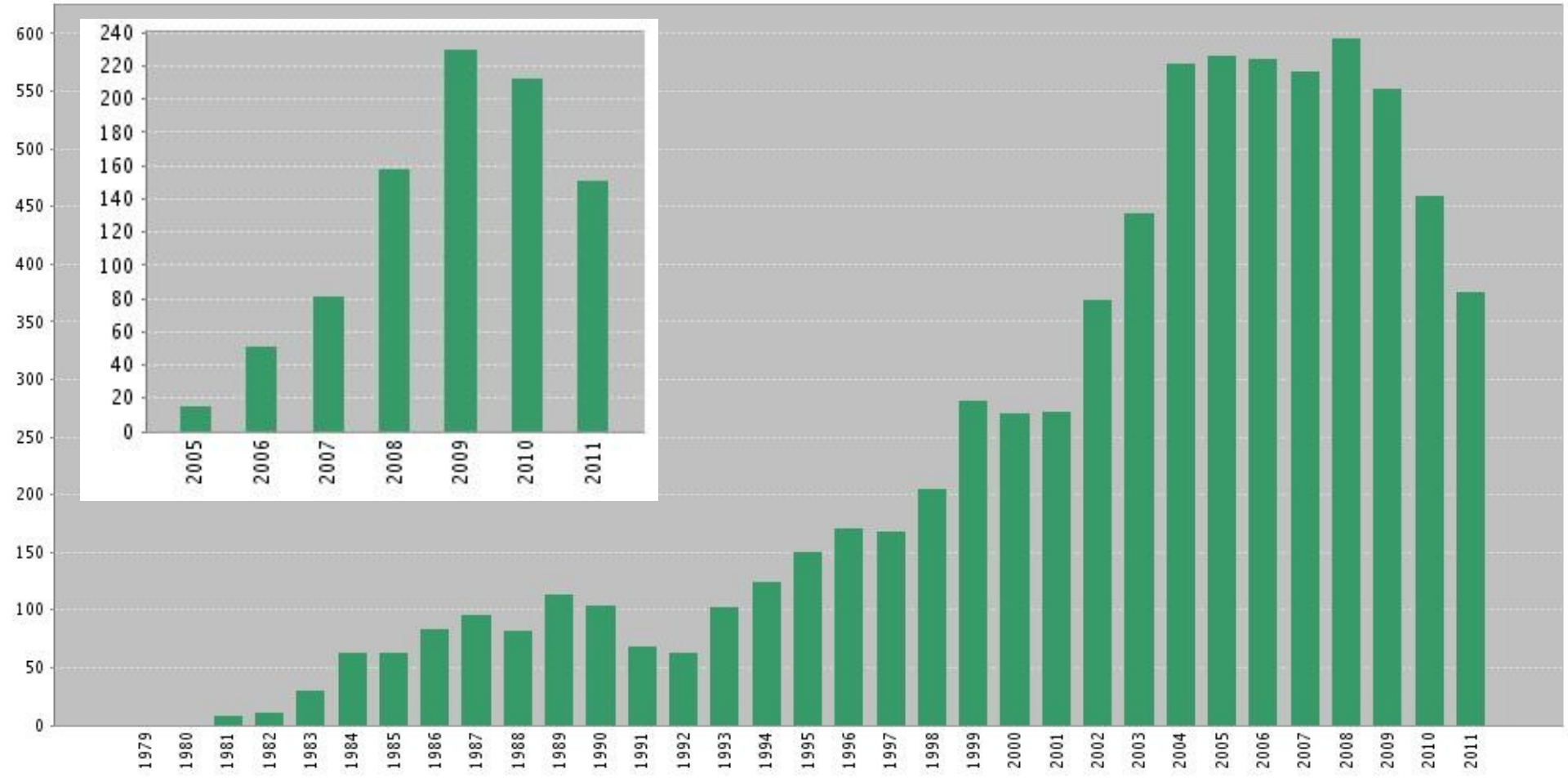
422 articles
519 categories

- NUCLEAR PHYSICS
- MULTIDISCIPLINARY PHYSICS
- FIELDS PARTICLES PHYSICS
- ASTRONOMY ASTROPHYSICS
- MATHEMATICAL PHYSICS
- MECHANICS
- MULTIDISCIPLINARY SCIENCES
- CHEMISTRY INORGANIC NUCLEAR
- FLUIDS PHYSICS PLASMAS
- THERMODYNAMICS
- OTHER

Publication activity



Citations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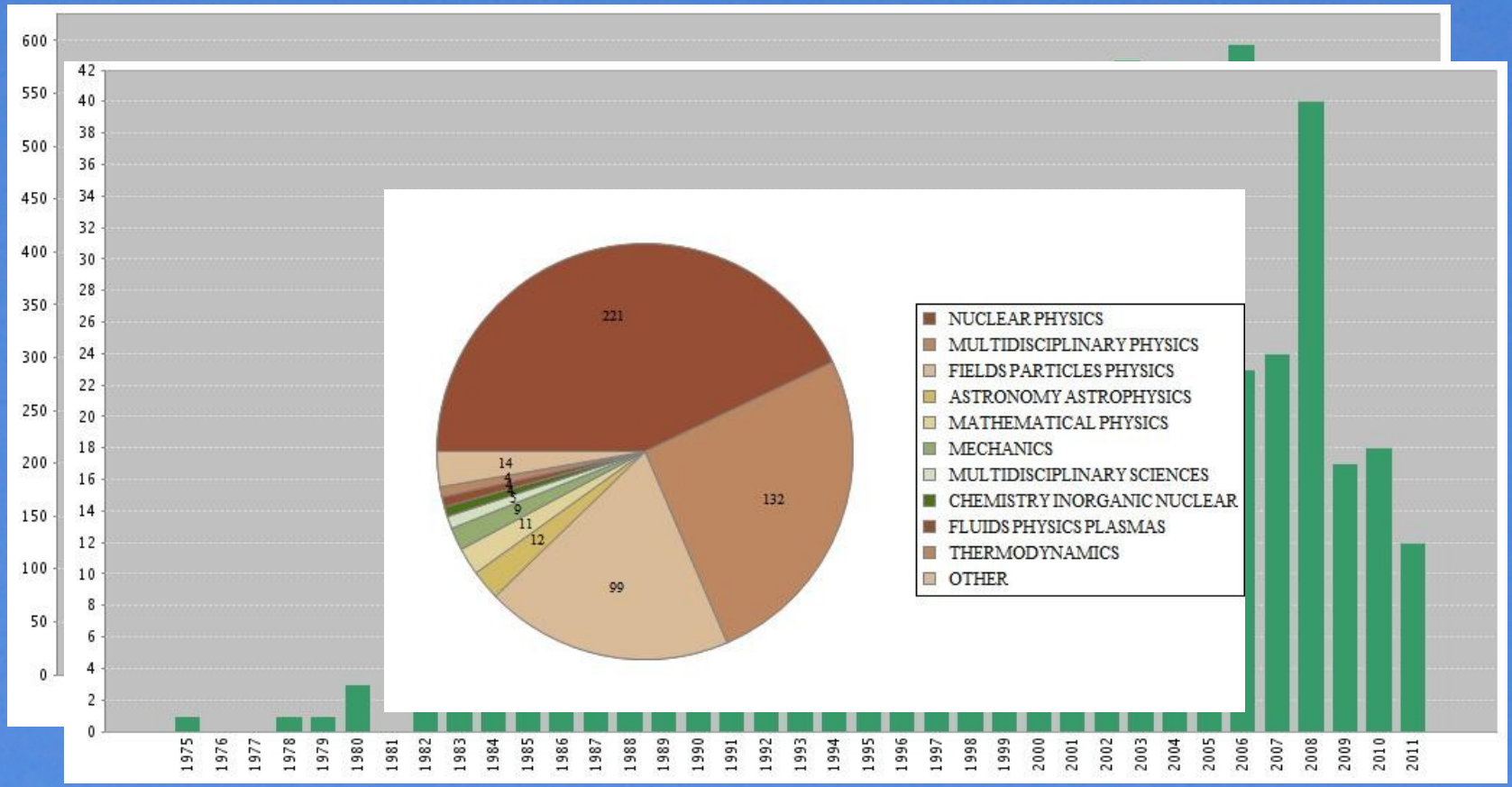
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