



TECHNISCHE
UNIVERSITÄT
DARMSTADT

NUSTAR at GSI Day-0
(Phase-0, 2018ff)

Heiko Scheit



TECHNISCHE
UNIVERSITÄT
DARMSTADT

July 31, 2015

(HI-induced) Electromagnetic Excitation



TECHNISCHE
UNIVERSITÄT
DARMSTADT

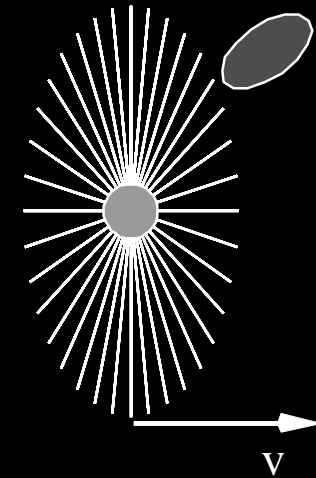
EM excitation

EM excitation (2)

Requirements

Summary

- excitation of projectile in Coulomb field of target



EM excitation

EM excitation (2)

Requirements

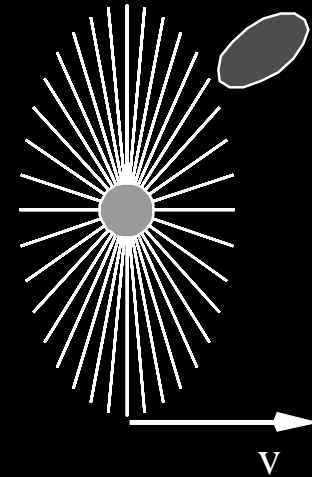
Summary

- excitation of projectile in Coulomb field of target
- Adiabaticity parameter

$$\xi = \frac{\tau_{\text{coll}}}{\tau_{\text{nucl}}}$$

$$\tau_{\text{nucl}} = \omega_{fi}^{-1} = \frac{\hbar}{E_x}$$

$$\tau_{\text{coll}} = \frac{b}{\gamma v}$$



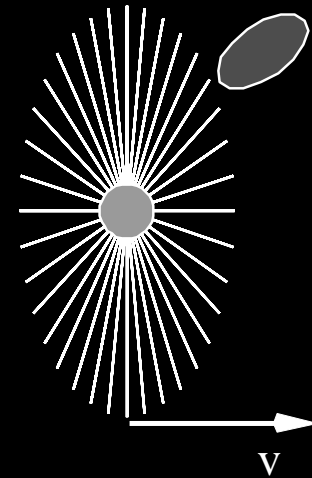
- excitation of projectile in Coulomb field of target

- Adiabaticity parameter

$$\xi = \frac{\tau_{\text{coll}}}{\tau_{\text{nucl}}}$$

$$\tau_{\text{nucl}} = \omega_{fi}^{-1} = \frac{\hbar}{E_x}$$

$$\tau_{\text{coll}} = \frac{b}{\gamma v}$$



- excitation only if $\xi < 1$ (fast collision)

$$E_x \leq \frac{\gamma\beta \cdot \hbar c}{b} \sim \gamma\beta \cdot 20 \text{ MeV}$$

(HI-induced) Electromagnetic Excitation (2)



TECHNISCHE
UNIVERSITÄT
DARMSTADT

EM excitation

EM excitation (2) |

Requirements

Summary

- 50 MeV/u: $E_x < 5$ MeV

(HI-induced) Electromagnetic Excitation (2)



TECHNISCHE
UNIVERSITÄT
DARMSTADT

EM excitation

EM excitation (2)

Requirements

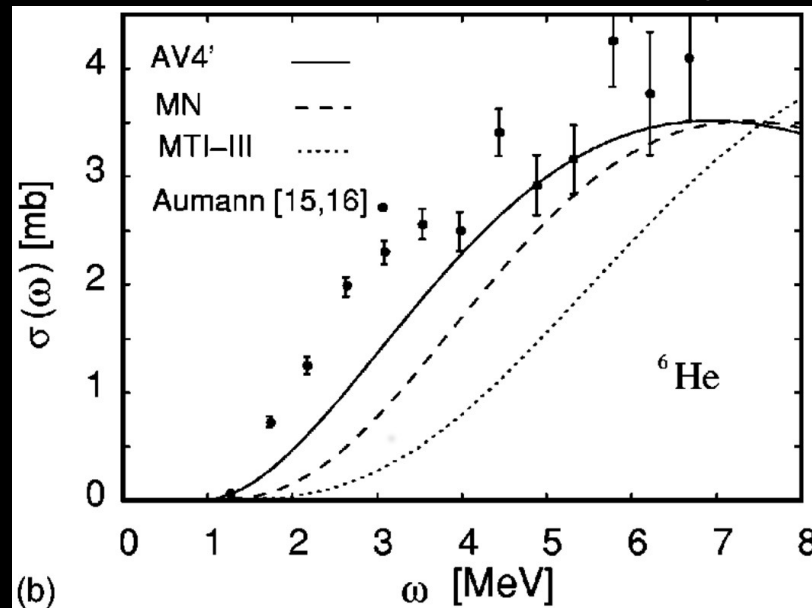
Summary

- 50 MeV/u: $E_x < 5$ MeV

- 1 GeV/u: $E_x < 40$ MeV

For instance: photo absorption cross section of ${}^6\text{He}$

S. Bacca et al. PRL 89, 052502 (2002); PRC 69, 057001 (2004)

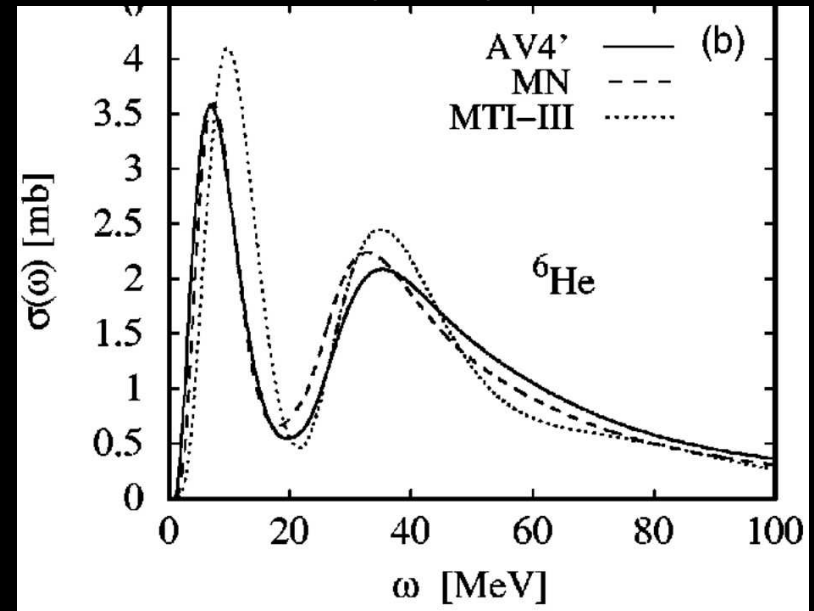
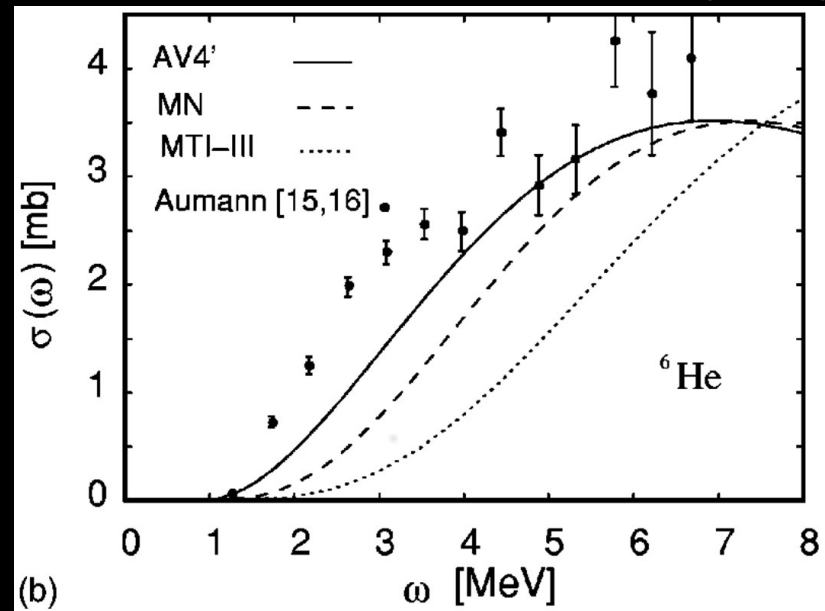


(HI-induced) Electromagnetic Excitation (2)

- EM excitation
- EM excitation (2) |
- Requirements
- Summary

- 50 MeV/u: $E_x < 5$ MeV
- 1 GeV/u: $E_x < 40$ MeV

For instance: photo absorption cross section of ${}^6\text{He}$
 S. Bacca et al. PRL 89, 052502 (2002); PRC 69, 057001 (2004)



for 2018: ${}^6\text{He}$ @ 1 GeV/u (GLAD needed)

(HI-induced) Electromagnetic Excitation (2)



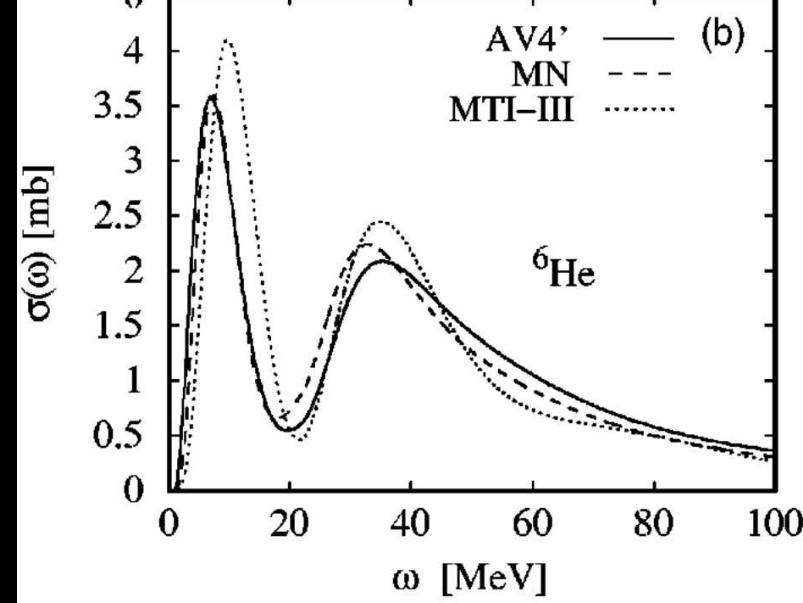
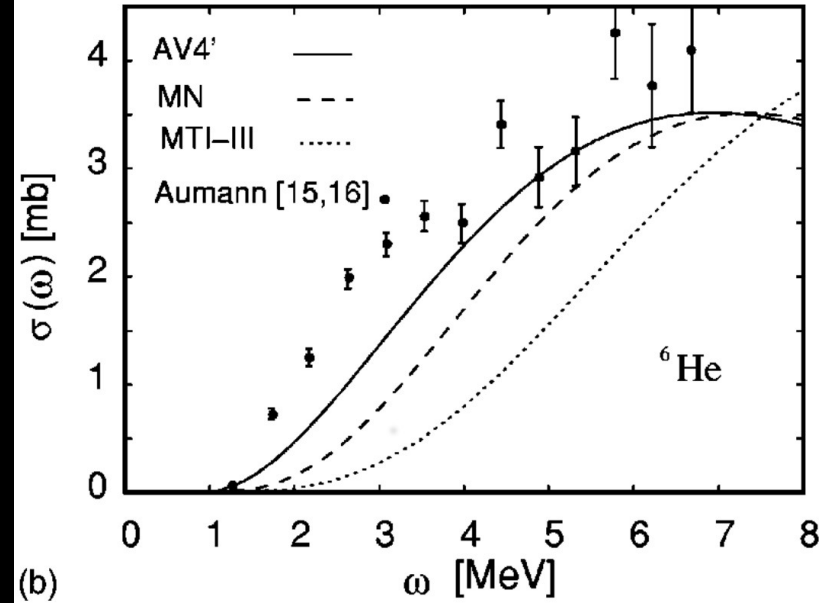
- EM excitation
- EM excitation (2) |
- Requirements
- Summary

- 50 MeV/u: $E_x < 5$ MeV

- 1 GeV/u: $E_x < 40$ MeV

For instance: photo absorption cross section of ${}^6\text{He}$

S. Bacca et al. PRL 89, 052502 (2002); PRC 69, 057001 (2004)



for 2018: ${}^6\text{He}$ @ 1 GeV/u (GLAD needed)

- 5 GeV/u: $E_x < 120$ MeV (\rightarrow EXL in **HESR**)



EM excitation
EM excitation (2)

Requirements |

Spill structure

Ion Source

Summary

Requirements



EM excitation

EM excitation (2)

Requirements

Spill structure

Ion Source

Summary

- slow extraction (loooooong spill, no structure)
- (fast only if < 1 particle /spill after (S)FRS)
- **PID** is measured for **each particle** before and after target
- $I_{beam} < 100$ kHz
- always want 1-5 MHz pulsing
→ mostly empty packets (after (S)FRS)
- regardless if problem with spill structure solved or not:
beam should **always** be **pulsed**



EM excitation
EM excitation (2)

Requirements

Spill structure

Ion Source

Summary

- for NUSTAR, the most important issue
- ~ 20 years ago: big problem with ^{48}Ca beam (10-20 PRL lost to MSU!!!)



EM excitation

EM excitation (2)

Requirements

Spill structure

Ion Source

Summary

- for NUSTAR, the most important issue
- ~ 20 years ago: big problem with ^{48}Ca beam (10-20 PRL lost to MSU!!!)
- Bi or Pb? **Pb**
- can go a long way with **U**
- look at nuclear chart: isotopes sticking out: ^{48}Ca , ^{64}Ni , ^{86}Kr , ^{136}Xe , ... + proton-rich side
- think about isotopes, not elements (low abundance, cost of enriched material)
- efficiency of ion source+acc. chain,
- what we really need: PAC
safe bet: C, O, ^{48}Ca , ^{208}Pb , U



EM excitation
EM excitation (2)

Requirements

Summary |

Summary

Summary

EM excitation

EM excitation (2)

Requirements

Summary

Summary

- slow extraction: **always** use 1–5 MHz pulsing (effect on beam intensity?)
- don't compromise at the ion source
- beams: C, O, ^{48}Ca , ^{208}Pb , **U**
intensity: **maximum**
- NUSTAR rather flexible in heavy region (south and east of Pb)
 - everything is new
 - if (initial) intensity not perfect, pick less exotic isotopes