

# Studying the structure of a bound proton through polarization-transfer measurements

Tim Kolar PANIC 2021 Conference Lisbon, 5. 9. 2021

# Motivation

• Does the proton change when embedded in nucleus?



VS.



## Motivation

• EMC effect: nucleus does have an affect on proton partonic structure



The per-nucleon cross-section ratio of various nuclei to deuterium as measured at SLAC (Gomez et al., 1994)

#### Quasi-elastic scattering



## Polarization transfer in $A(\vec{e}, e'\vec{p})$ reaction



### Polarization transfer in $A(\vec{e}, e'\vec{p})$ reaction



## Polarization transfer in $A(\vec{e}, e'\vec{p})$ reaction



#### Polarization transfer experiments



• Universal behaviour for different nuclei

### Polarization transfer experiments



• Universal behaviour for different nuclei

Dominated by other nuclear medium effects, such as *final-state interactions* (FSI), *meson-exchange currents* (MEC) and *isobar currents* (IC)
 → need to be accounted for with theoretical calculations

### **Different** Approach



# Experimental setup in A-Hall at Mainz

# $\circ$ A1-Hall

#### 3 magnetic spectrometers





### The Experiment - kinematics

• Central kinematics:

$E_{\rm beam}$	[MeV]	600
$Q^2$	$\left[\mathrm{GeV}^2/c^2\right]$	0.175
$p_e$	[MeV/c]	368
$ heta_e$	[°]	-52.9
$p_p$	[MeV/c]	665
$ heta_p$	[°]	37.8
$p_{ m miss}$	[MeV/c]	-270 to $-100$
ν	$\left[\mathrm{MeV}^2/c^2\right]$	-160 to $-40$



• Covered  $p_{\text{miss}}$ - $\nu$  phase space:

### The Experiment

 $\circ$  Separation of protons ejected from s and p shell



Limits were based on previously measured spectral functions for  $^{12}C$  (Dutta, 2003)

$$p_{3/2}$$
 shell:  $14 \le E_{miss} \le 25 \text{ MeV}$   
 $s_{1/2}$  shell:  $30 \le E_{miss} \le 60 \text{ MeV}$ 

• Individual polarization components



### The Experiment - Results

• Polarization double ratio - comparison between the two <sup>12</sup>C shells in the virtuality overlap region



- $\rightarrow$  Forming polarization double ratio  $\frac{(P'_x/P'_z)^s_{12_{\rm C}}}{(P'_x/P'_z)^p_{12_{\rm C}}}$  reduces FSI contribution
- $\rightarrow$  Based on the s- and p- shell comparison there is no density-dependent modification of protons with the same virtuality

### The Experiment - Results

#### • Polarization double ratio - comparison with a free proton



 $\to$  Observed universality of  $\frac{(P_x/P_z)_A}{(P_x/P_z)_H}$  when examined as function of virtuality is perserved

# Conclusions

- We presented a novel method for exploration of in-medium effects with polarization transfer method
- Theoretical imput remains mandatory
- For protons of the same virtuality we did not observe any density-dependent modifications
- Perserved universality of  $\frac{(P_x/P_z)_A}{(P_x/P_z)_H}$  when examined as function of virtuality
- $\circ$  Similar experiment with  $^{40}\mathrm{Ca}$  target is approved to run at MAMI

# Thank you!

