

# Entdeckung des Positrons in kosmischer Strahlung durch C.D.Anderson

Phys. Rev. 43 (1933) 491 in Nebelkammer

Nebelkammer: übersättigter Dampf, Ionisation bildet Kondensationskeime (Tröpfchen)

$17 \times 17 \times 3 \text{ cm}^3$  in 1.5 T Magnetfeld, ungetriggert)

Impuls (aus Krümmung der Spur) 63 bzw. 23 MeV/c

Richtung der Spur?

Einbringen einer Bleiplatte

Masse? aus Impuls und

Reichweite 50 mm

Proton wurde in 5 mm

stoppen

Beobachtung einiger Ereignisse

→ Masse innerhalb 20% gleich Elektron

6 mm Pb

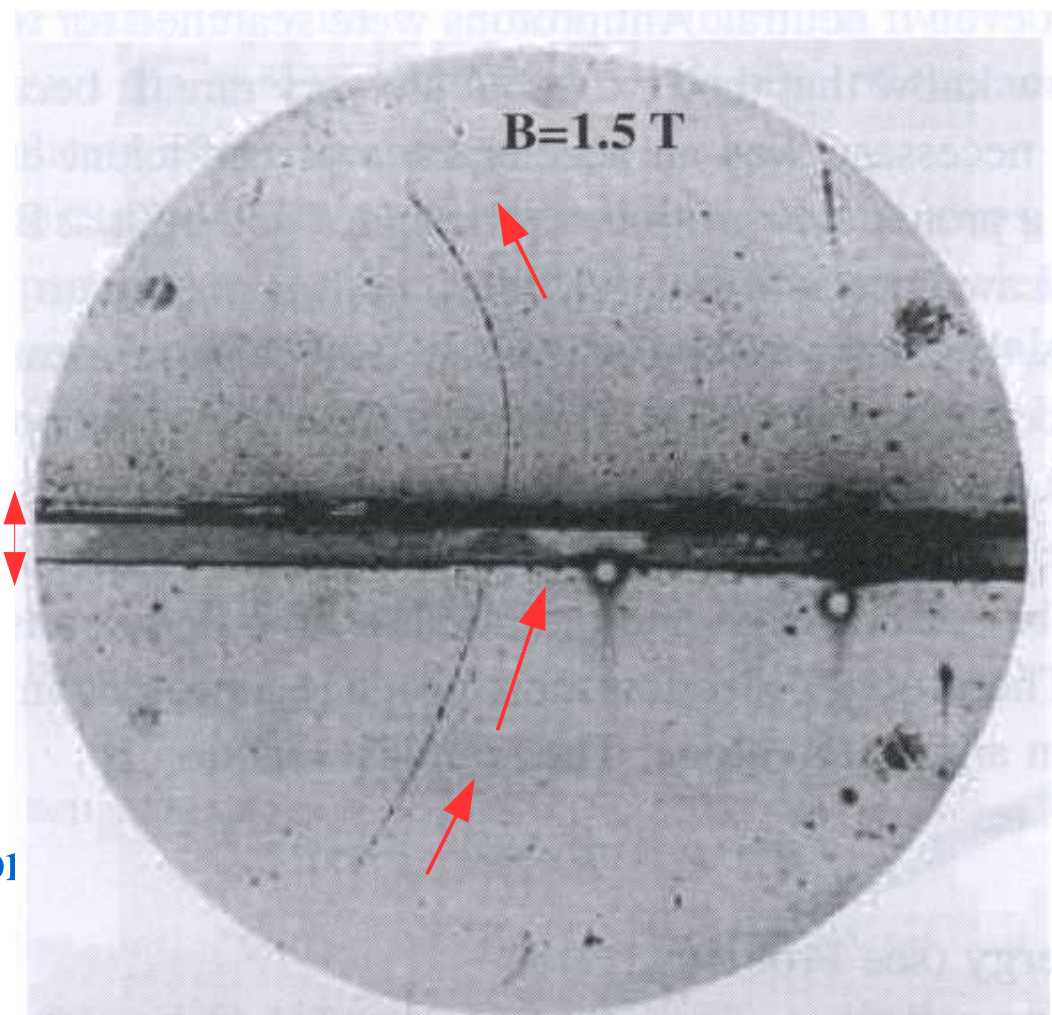
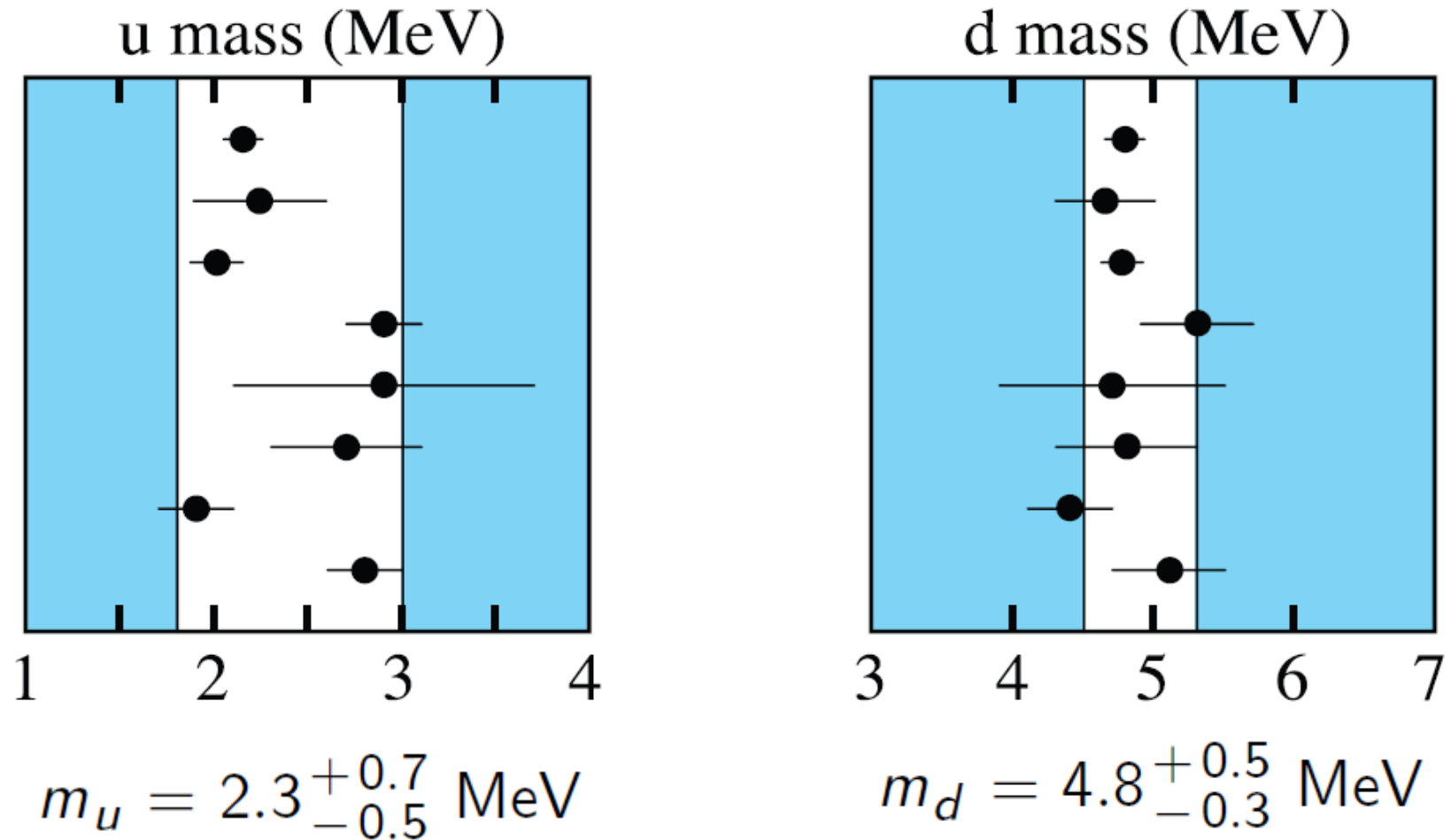


Fig. 5-2

## up und down Quark Massen

aus theoretischen Berechnungen hadronischer Eigenschaften



A.V. Manohar, C.T. Sachrajda in Review of Particle Physics, PDG 2014

Fig. 5-4

# die fundamentalen Teilchen, aus denen alles besteht:

## FERMIONS

matter constituents  
spin = 1/2, 3/2, 5/2, ...

### Leptons spin = 1/2

Flavor	Mass GeV/c <sup>2</sup>	Electric charge
$\nu_L$ lightest neutrino*	$(0-2) \times 10^{-9}$	0
<b>e</b> electron	0.000511	-1
$\nu_M$ middle neutrino*	$(0.009-2) \times 10^{-9}$	0
$\mu$ muon	0.106	-1
$\nu_H$ heaviest neutrino*	$(0.05-2) \times 10^{-9}$	0
$\tau$ tau	1.777	-1

### Quarks spin = 1/2

Flavor	Approx. Mass GeV/c <sup>2</sup>	Electric charge
<b>u</b> up	0.002	2/3
<b>d</b> down	0.005	-1/3
<b>c</b> charm	1.3	2/3
<b>s</b> strange	0.1	-1/3
<b>t</b> top	173	2/3
<b>b</b> bottom	4.2	-1/3



Quarks kommen in der Natur nur in gebundenen Zuständen vor: Hadronen

Fig. 5-5

# die fundamentalen Wechselwirkungen

elektromagnetisch

schwache Wechselwirkung

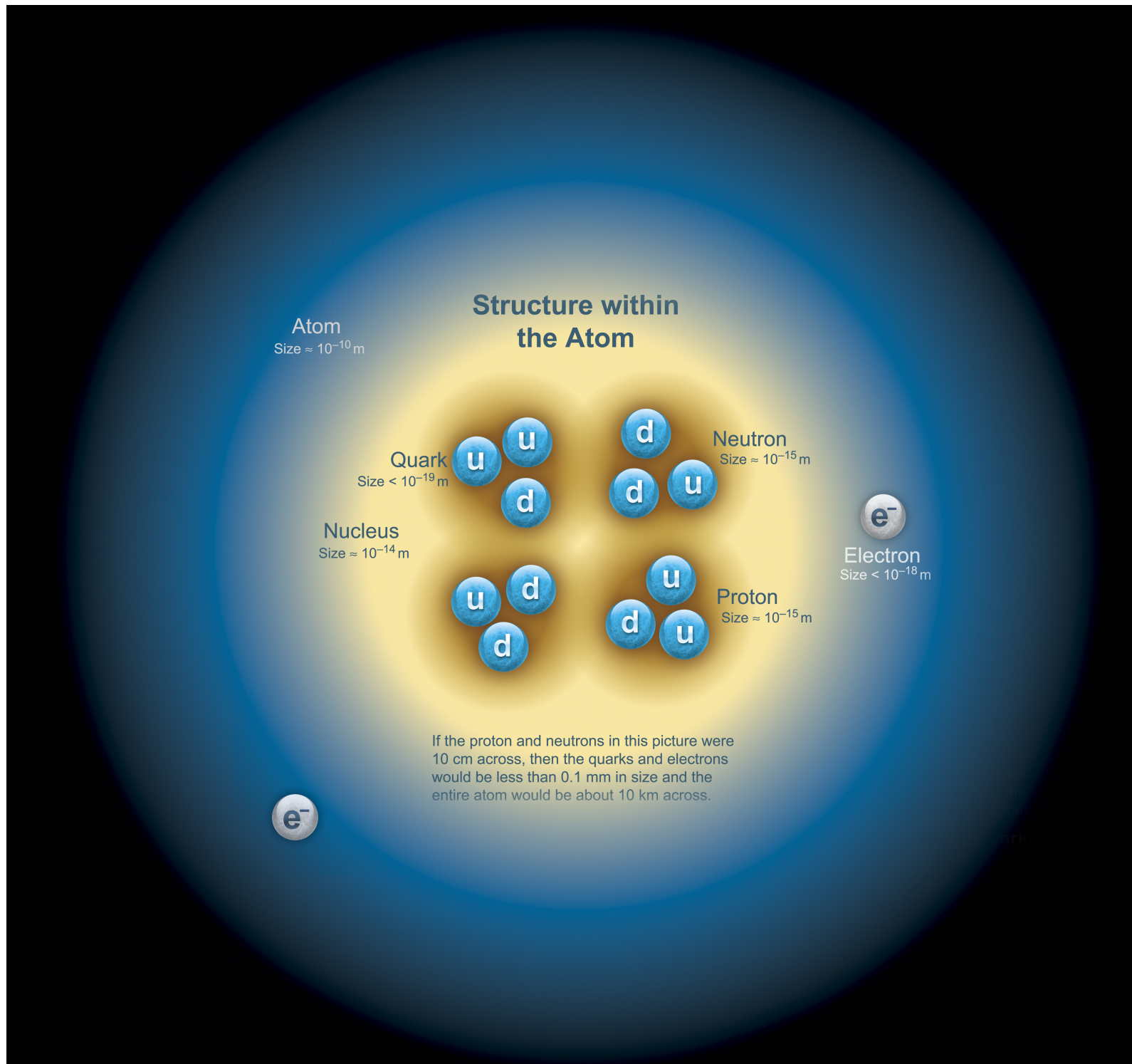
neu 

starke Wechselwirkung

Gravitation (in PEP5 nicht wichtig)

<b>BOSONS</b>			force carriers spin = 0, 1, 2, ...		
<b>Unified Electroweak spin = 1</b>			<b>Strong (color) spin = 1</b>		
Name	Mass GeV/c <sup>2</sup>	Electric charge	Name	Mass GeV/c <sup>2</sup>	Electric charge
$\gamma$ photon	0	0	<b>g</b> gluon	0	0
<b>W<sup>-</sup></b>	80.39	-1			
<b>W<sup>+</sup></b> W bosons	80.39	+1			
<b>Z<sup>0</sup></b> Z boson	91.188	0			
<b>Higgs Boson spin = 0</b>					
Name	Mass GeV/c <sup>2</sup>	Electric charge	Name	Mass GeV/c <sup>2</sup>	Electric charge
<b>H</b> Higgs	126	0			

Fig. 5-6



### Structure within the Atom

Atom  
Size  $\approx 10^{-10}$  m

Quark  
Size  $< 10^{-19}$  m

Nucleus  
Size  $\approx 10^{-14}$  m

Neutron  
Size  $\approx 10^{-15}$  m

Electron  
Size  $< 10^{-18}$  m

Proton  
Size  $\approx 10^{-15}$  m

If the proton and neutrons in this picture were 10 cm across, then the quarks and electrons would be less than 0.1 mm in size and the entire atom would be about 10 km across.

Fig. 5-7

# Elektronenstreuung an $^{40}\text{Ca}$

$$q = 2 \text{ fm}^{-1} \hat{=} 400 \text{ MeV}/c$$

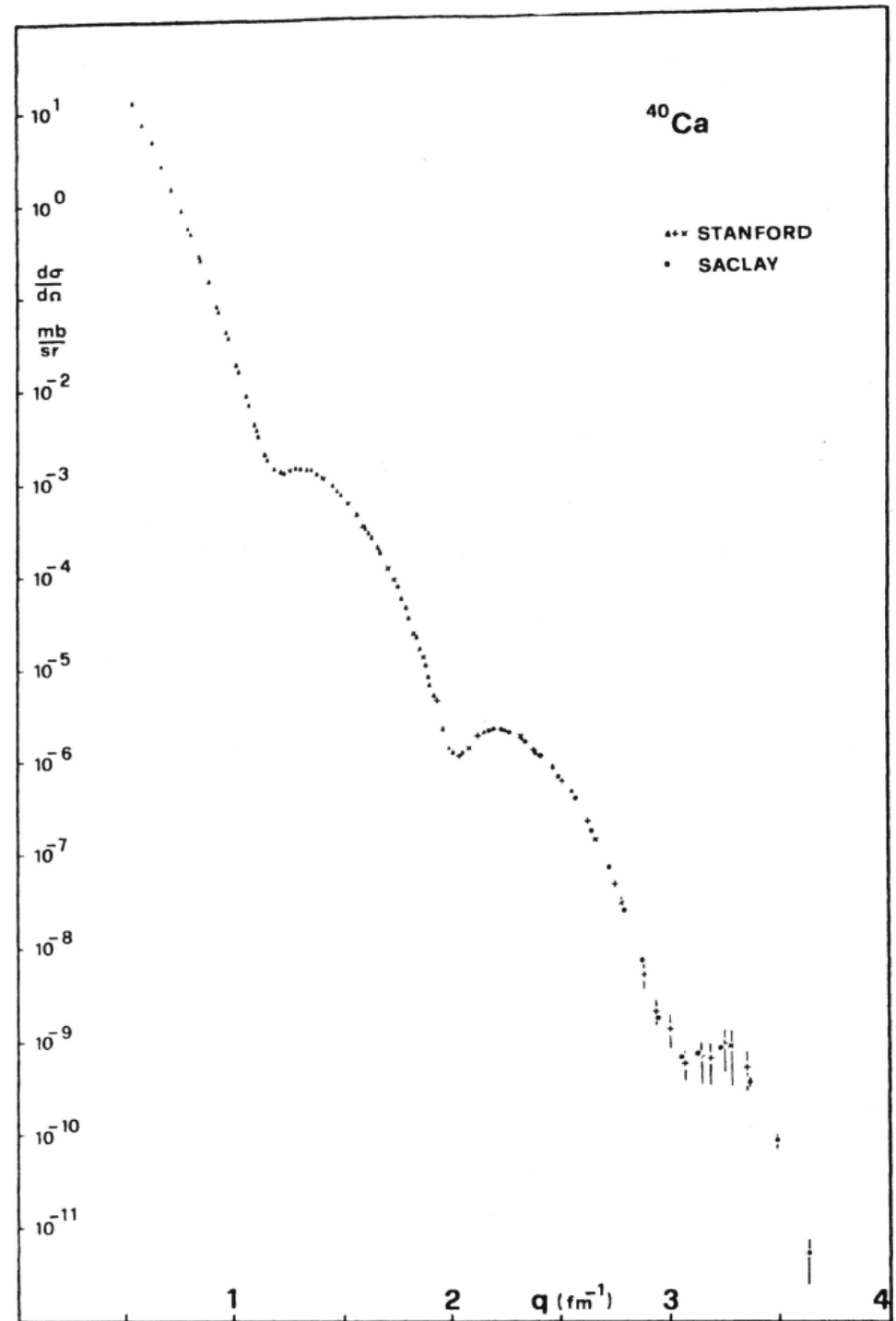


Fig. 6-1