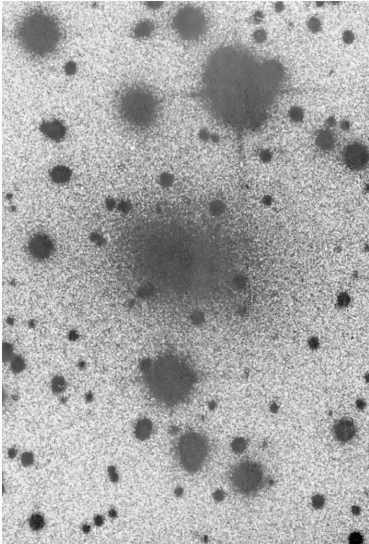


relativistische Betrachtung von Bewegungen

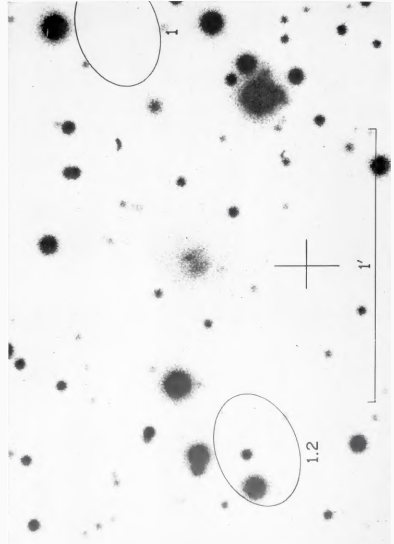
Alexander Helbok

19. Januar 2024

Radiobeobachtungen

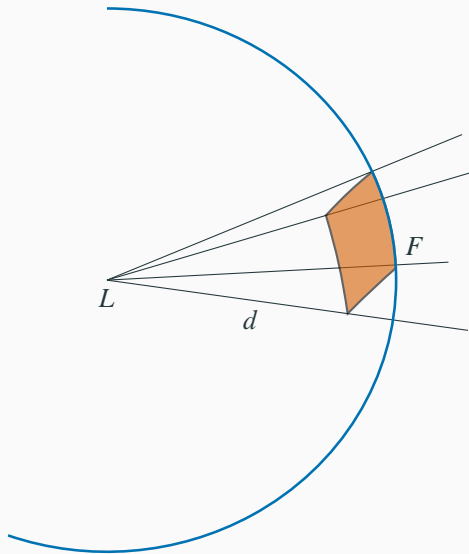


(Matthews, Morgan und Schmidt 1964)



(Matthews, Morgan und Schmidt 1964)

Leuchtkraft von 3C 273



Entfernung über Rotverschiebung

$$(z = 0.158)$$



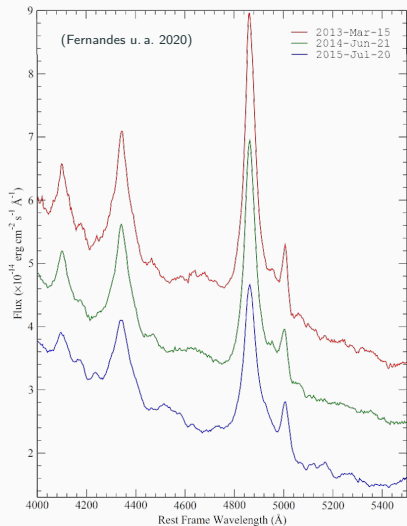
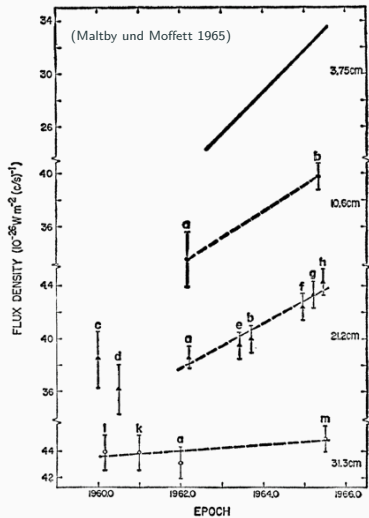
$$L = 4\pi d^2 F$$



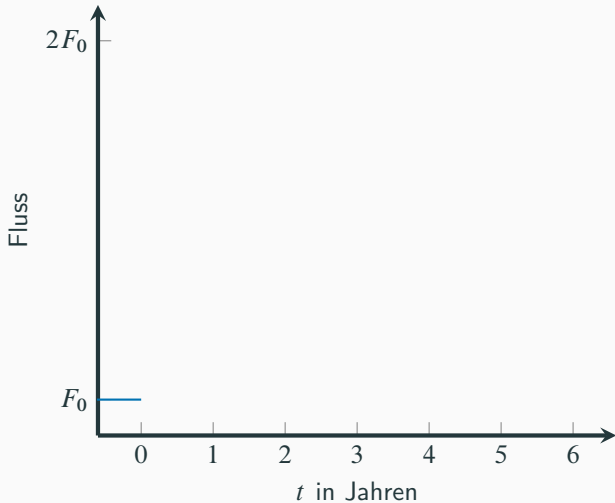
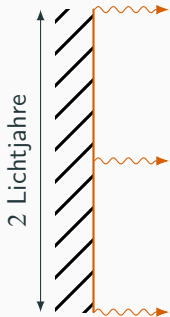
Flussmessung im Radiobereich

\Rightarrow extrem Hell

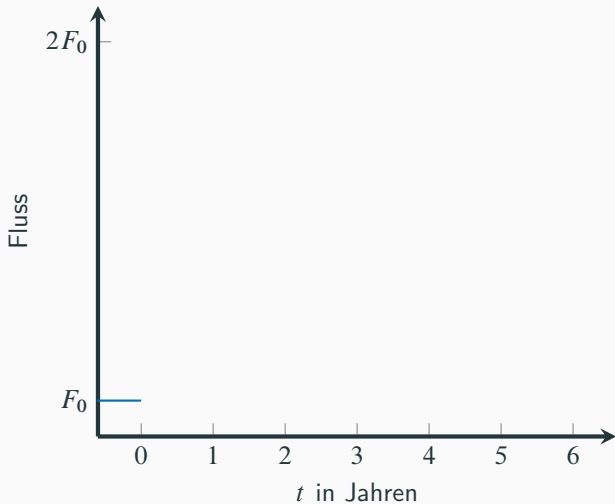
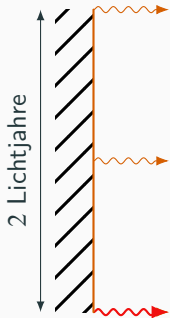
Helligkeitsschwankungen in 3C 273



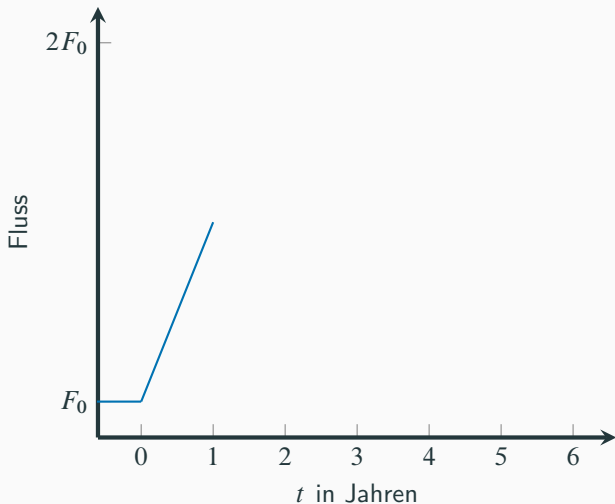
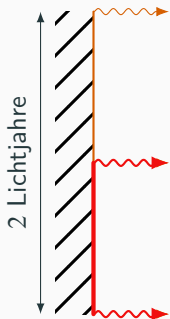
Fluktuationen erklärt



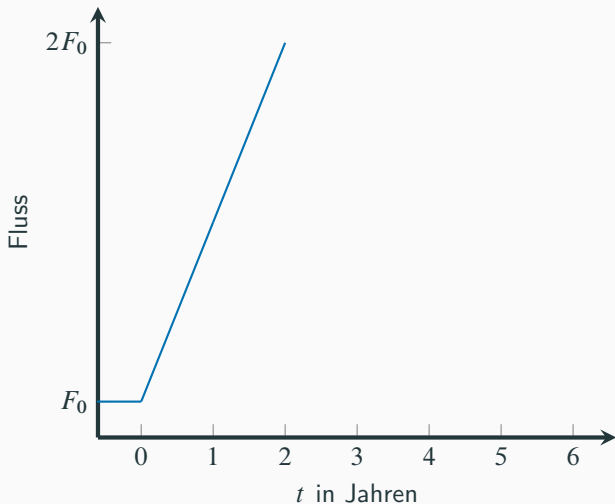
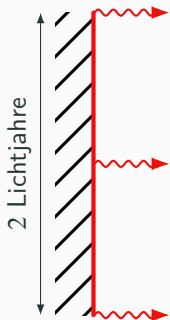
Fluktuationen erklärt



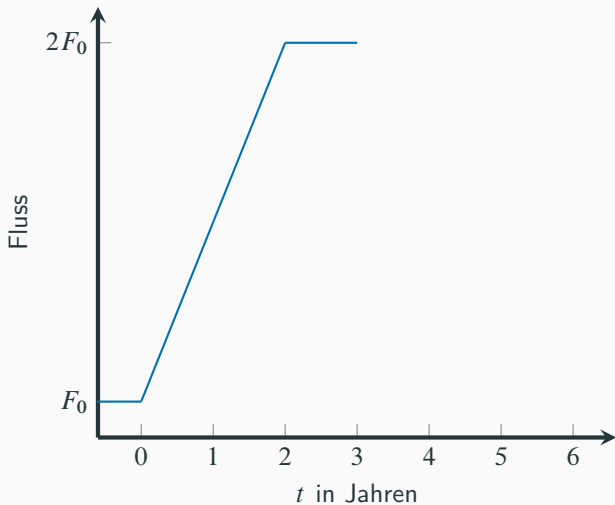
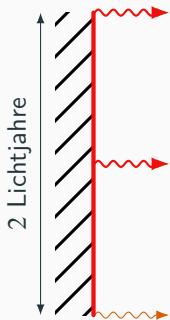
Fluktuationen erklärt



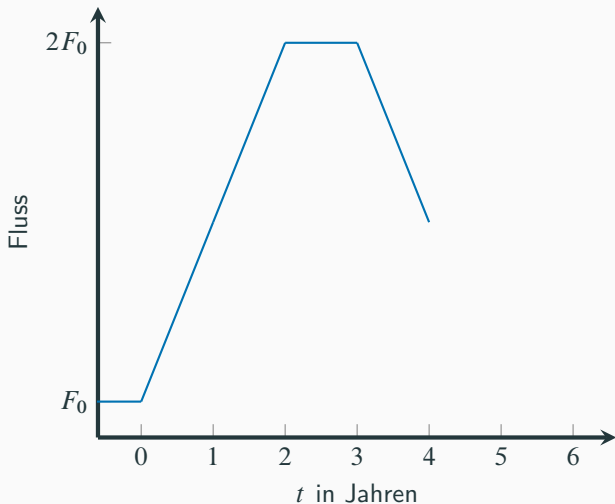
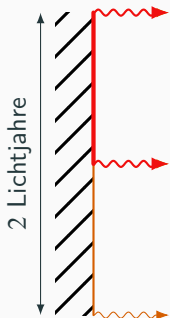
Fluktuationen erklärt



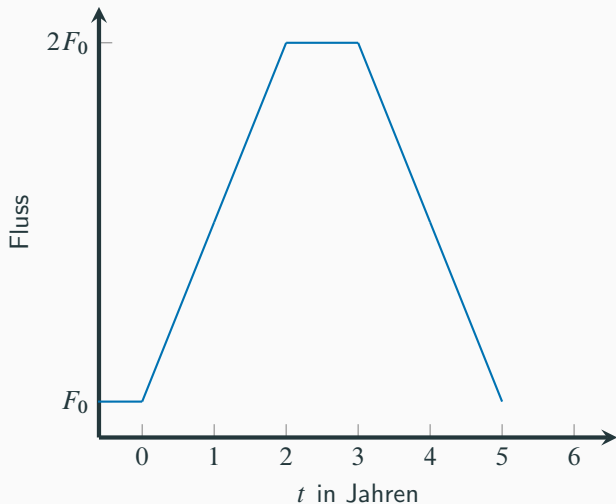
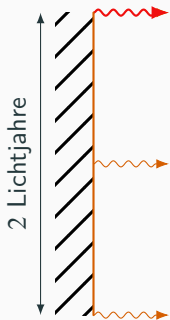
Fluktuationen erklärt



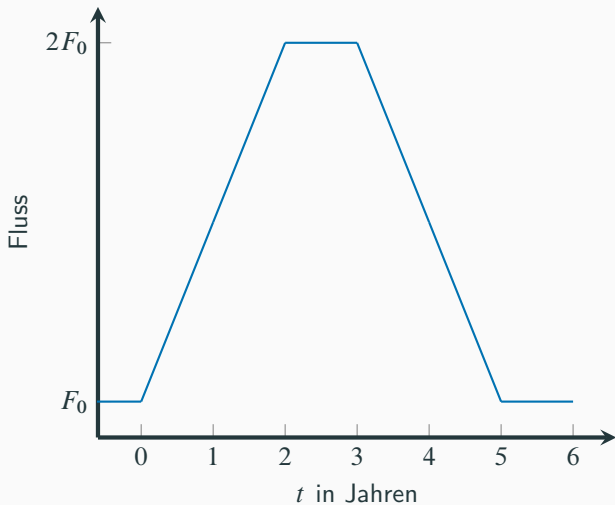
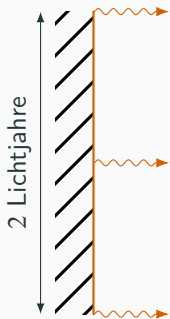
Fluktuationen erklärt



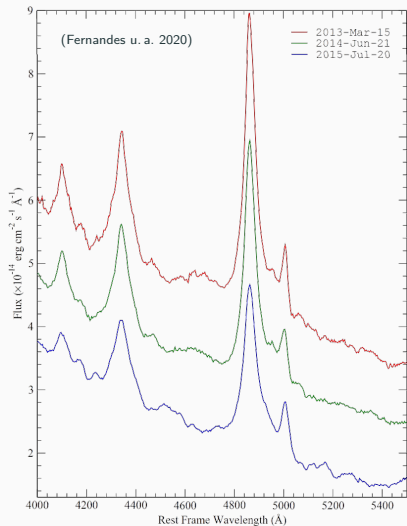
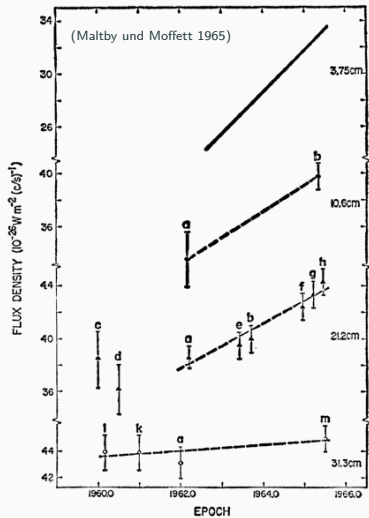
Fluktuationen erklärt



Fluktuationen erklärt



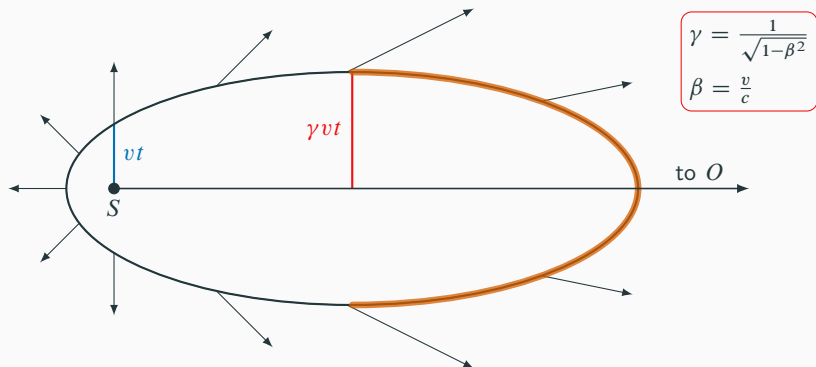
Helligkeitsschwankungen in 3C 273



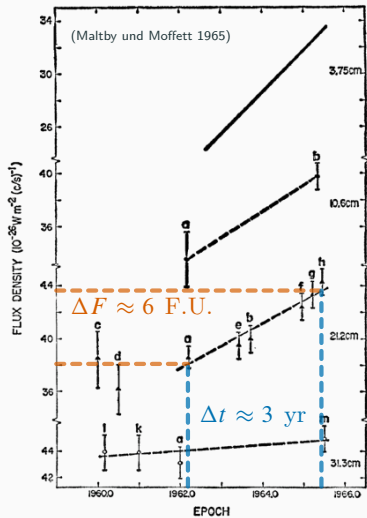
sphärische Expansion $v \ll c$



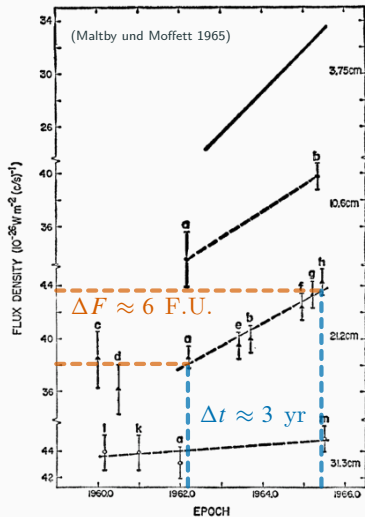
sphärische Expansion $v \sim c$



Beobachtung



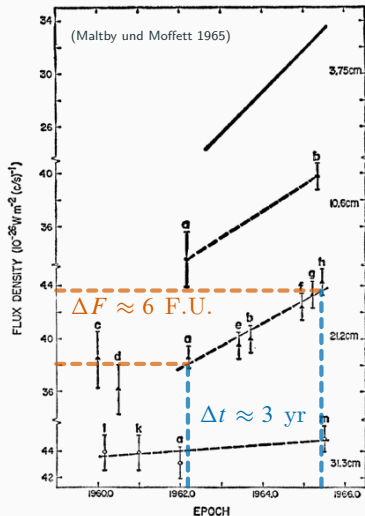
Beobachtung



„Because the **observed intensity** of a source, for a given **surface brightness**, is proportional to the **apparent size**“ [4]

$$F = B \triangle \propto 2 \frac{\gamma v t}{R}$$

Beobachtung

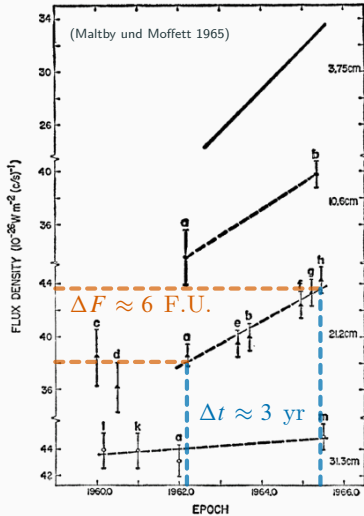


„Because the **observed intensity** of a source, for a given **surface brightness**, is proportional to the **apparent size**“ [4]

$$F = B \triangleleft \propto 2 \frac{\gamma v t}{R} \quad \frac{dF}{dt} = 2 \frac{\gamma v}{R} \propto \gamma$$

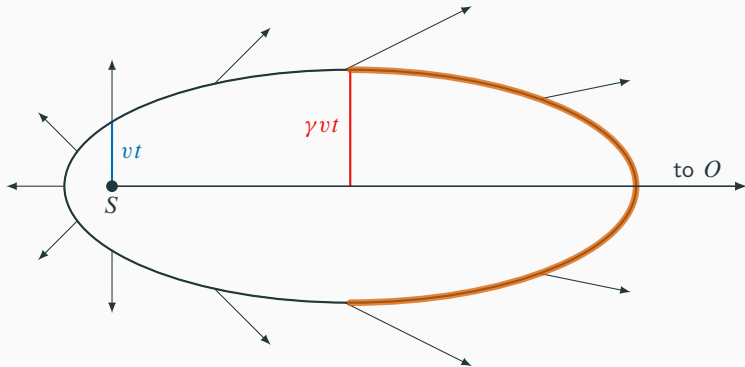
„it is already clear that an expanding source could exhibit a rate of increase of flux density high enough to explain the observations.“ [4]

Beobachtung



„If, however, a source at the distance of 3C 273 were to start to explode with a velocity corresponding to $\gamma = 5$, and if H (measured in a frame sharing the mean particle motion) $\sim 10^{-2}$ gauss, the flux density would have risen to $\sim 15 \text{ F.U.}$ in 3 years“ [4]

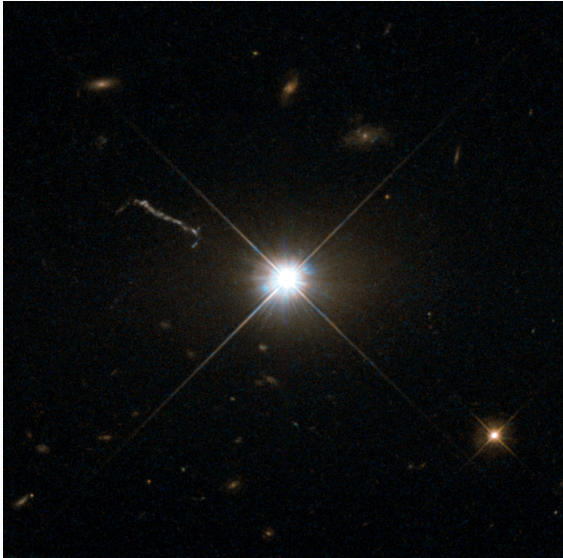
Konsequenz



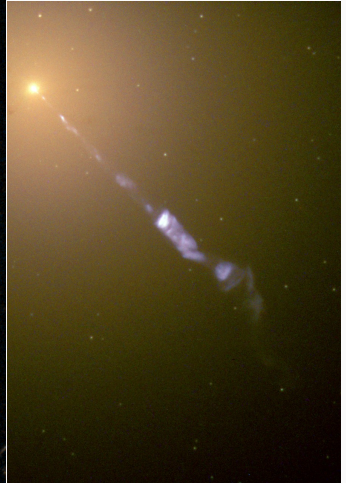
$$\beta = \frac{v}{c} \in [0; 1]$$

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} \in [1, \infty) \quad \Rightarrow \quad \gamma v > c \text{ möglich!}$$

Kosmische Jets

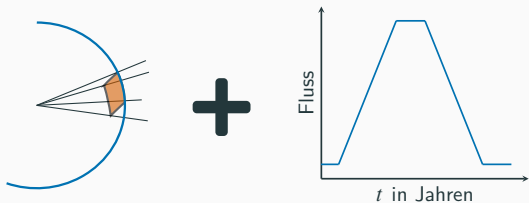


3C 273 © ESA/HUBBLE & NASA

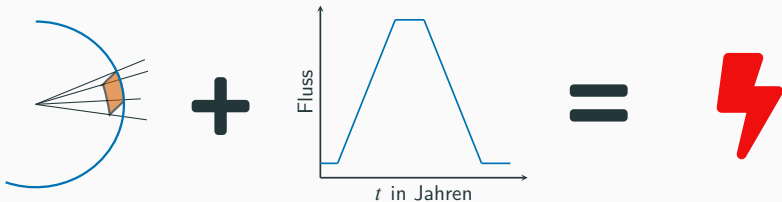


M87 © ESA/HUBBLE & NASA

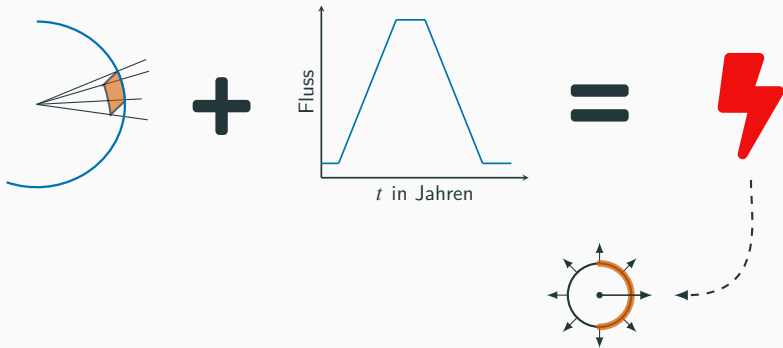
Recap



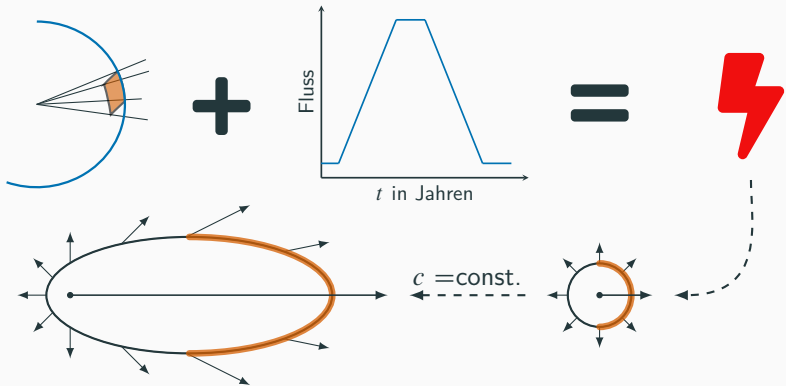
Recap



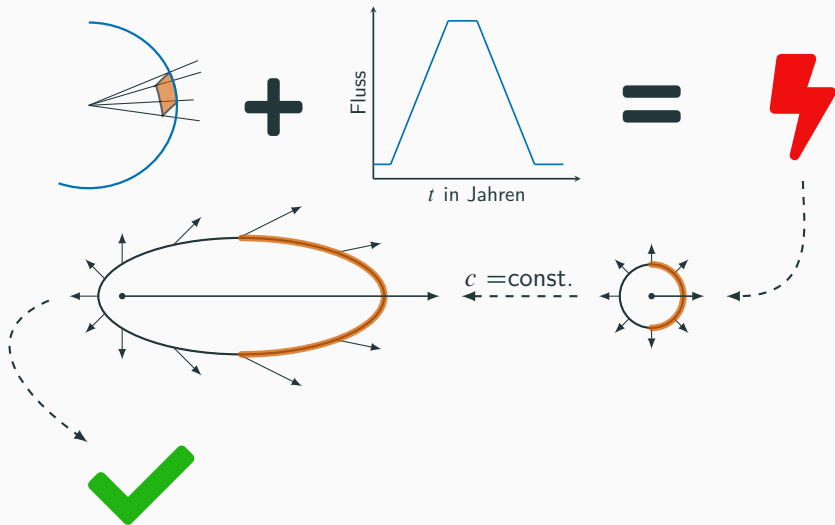
Recap



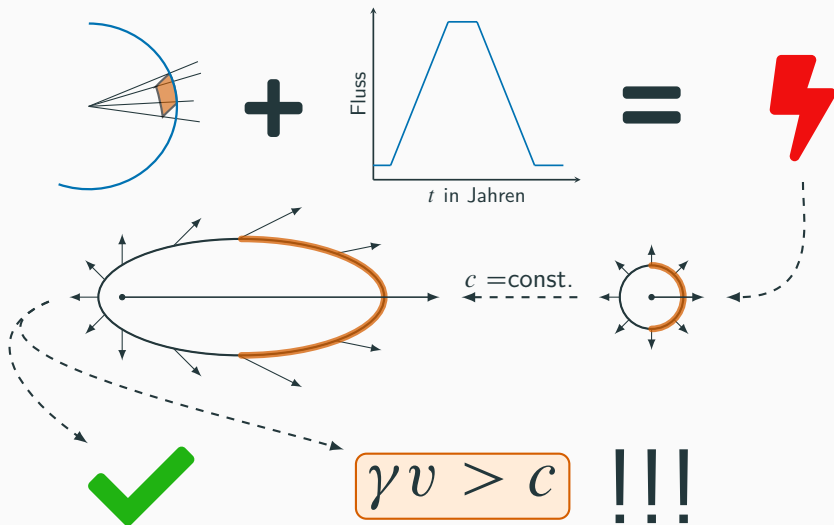
Recap



Recap



Recap



Fragen?

Relativistische Expansion

$$\beta = 0.835, \gamma = 1.82$$

$$t = 0$$



to O

A horizontal arrow pointing to the right, indicating the direction of observation or measurement.

Relativistische Expansion

$$\beta = 0.835, \gamma = 1.82$$

$$t = 0.25$$



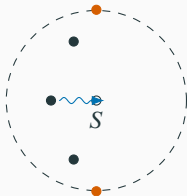
to O

A horizontal arrow pointing to the right, indicating the direction of observation or measurement towards a point O .

Relativistische Expansion

$$\beta = 0.835, \gamma = 1.82$$

$$t = 0.59$$



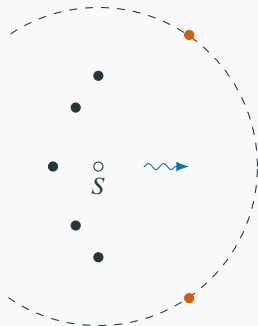
to O



Relativistische Expansion

$$\beta = 0.835, \gamma = 1.82$$

$$t = 1.5$$

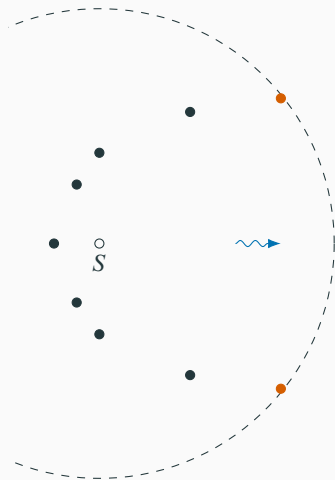


to O

Relativistische Expansion

$$\beta = 0.835, \gamma = 1.82$$

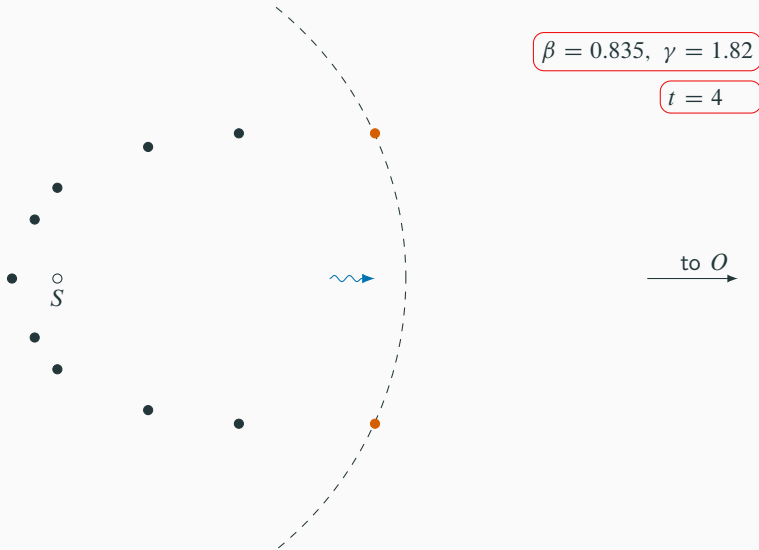
$$t = 2.5$$



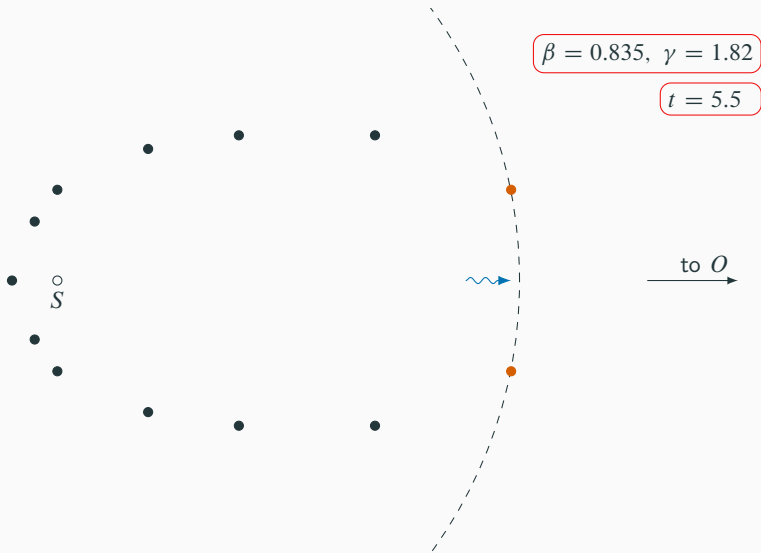
to O



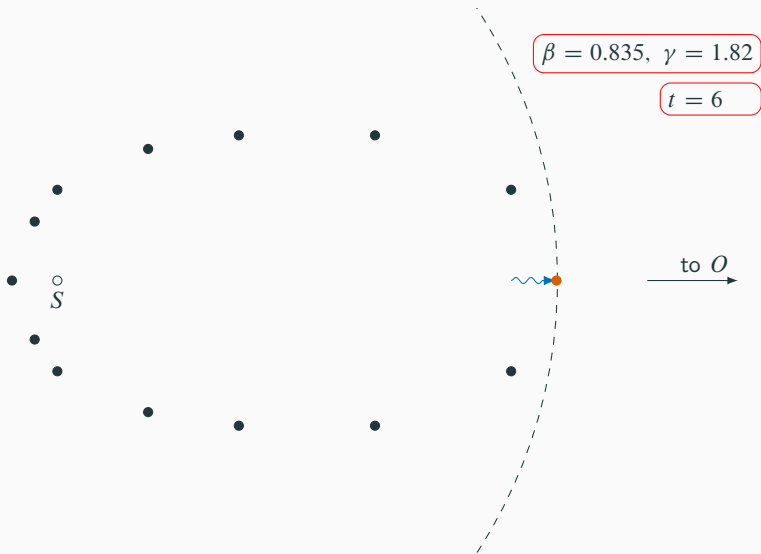
Relativistische Expansion



Relativistische Expansion



Relativistische Expansion



Relativistische Expansion

$$\beta = 0.835, \gamma = 1.82$$

$$t > 6$$



Literatur

- [1] T. A. Matthews, W. W. Morgan und M. Schmidt. „**A Discussion of Galaxies Identified with Radio Sources.**“. In: *Astrophysical Journal*, vol. 140, p. 35 140 (1964), S. 35.
- [2] P. Maltby und A. T. Moffett. „**Spectrum of the Intensity Variations in 3C 273B**“. In: *Science* 150.3692 (1965), S. 63–64. ISSN: 00368075, 10959203. URL: <http://www.jstor.org/stable/1717963> (besucht am 28.12.2023).

- [3] S. Fernandes u. a. „**Multiwavelength analysis of the variability of the blazar 3C 273**“. In: *Monthly Notices of the Royal Astronomical Society* 497.2 (Juli 2020), S. 2066–2077. ISSN: 1365-2966. URL: <http://dx.doi.org/10.1093/mnras/staa2013>.
- [4] M. Rees. „**Appearance of relativistically expanding radio sources**“. In: *Nature* 211.5048 (1966), S. 468–470.