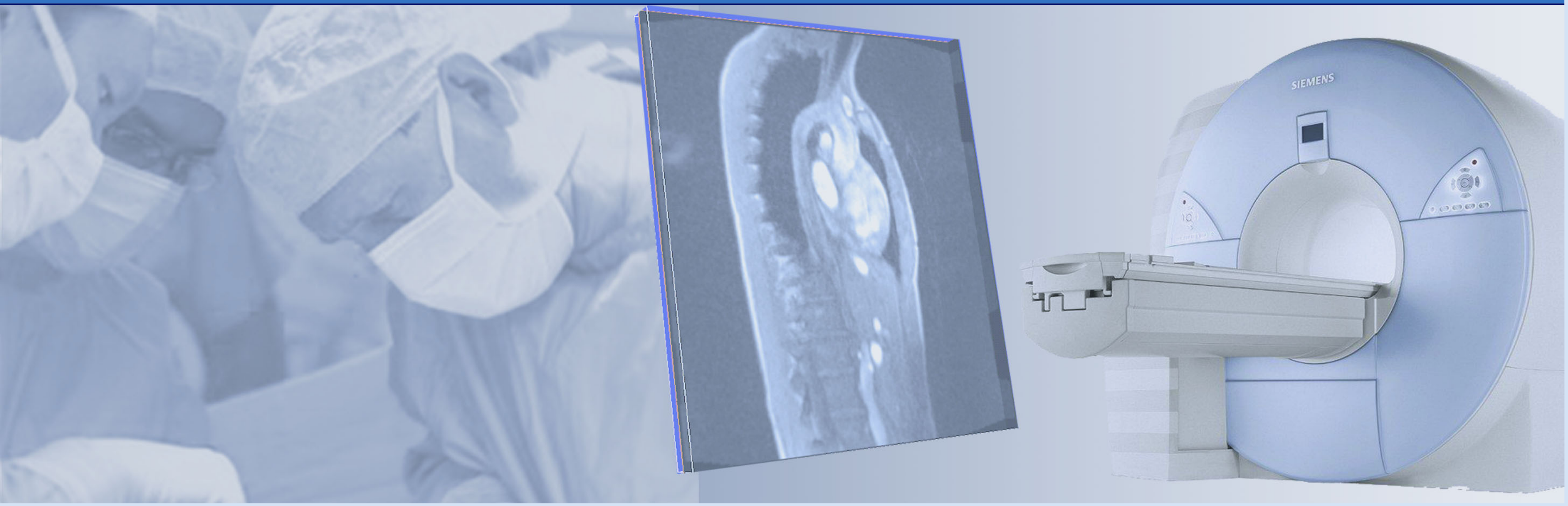
Tutorial computer- and robot-assisted surgery



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getragen von:
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Universitätsklinikum Carl Gustav Carus Dresden
Medizinische Fakultät Carl Gustav Carus, TU Dresden
Helmholtz-Zentrum Dresden-Rossendorf

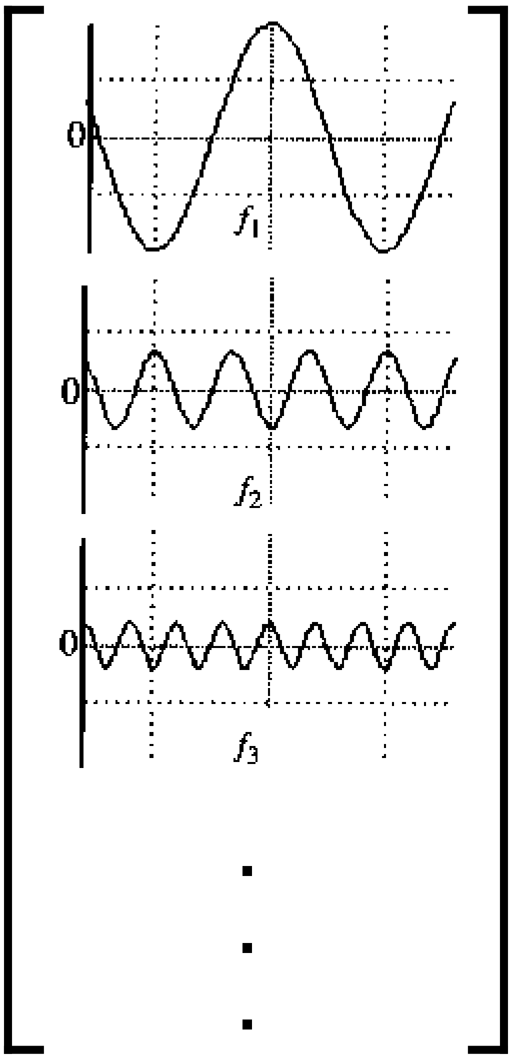
Sebastian Bodenstedt
Translational Surgical Oncology

Any questions from the lecture?

Review
Fourier
Transform

Fourier Transform – Change in basis

$$M * f(x) = F(\upsilon)$$



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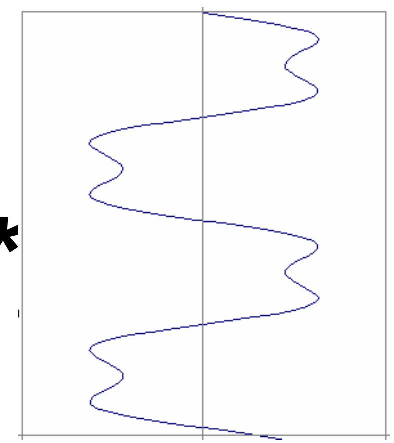

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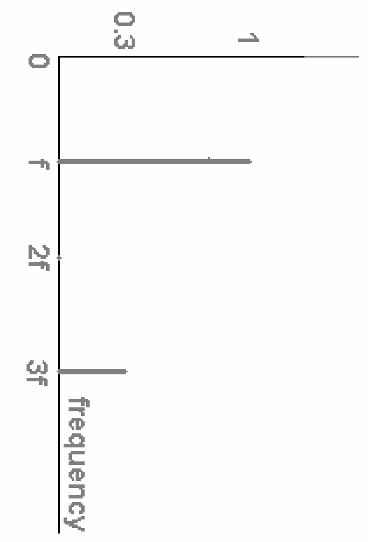
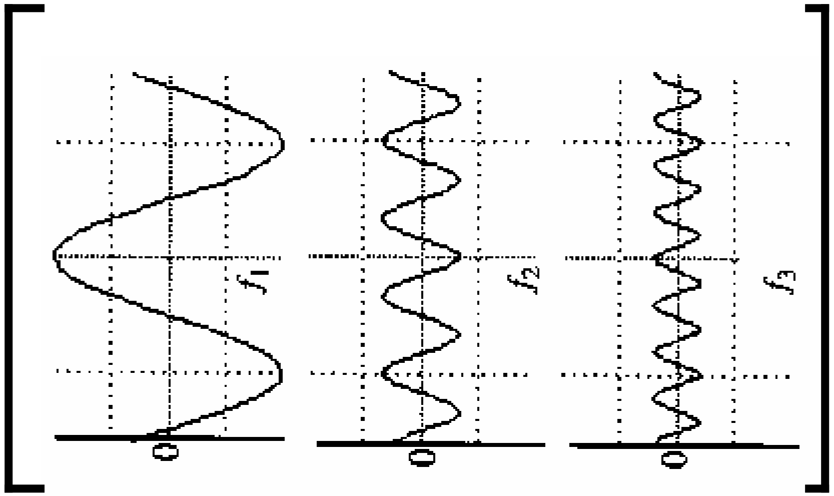


Fourier Transform – Change in basis

$$M^{-1} * F(\upsilon) = f(x)$$



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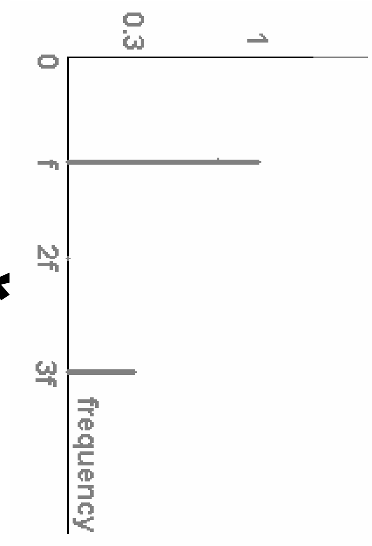

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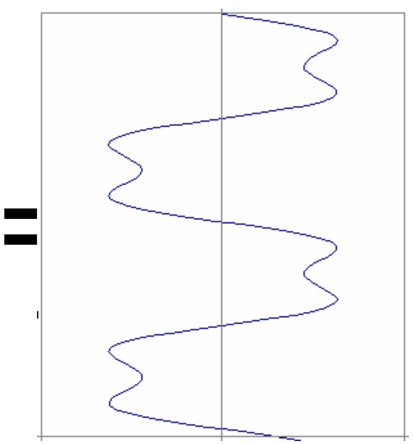


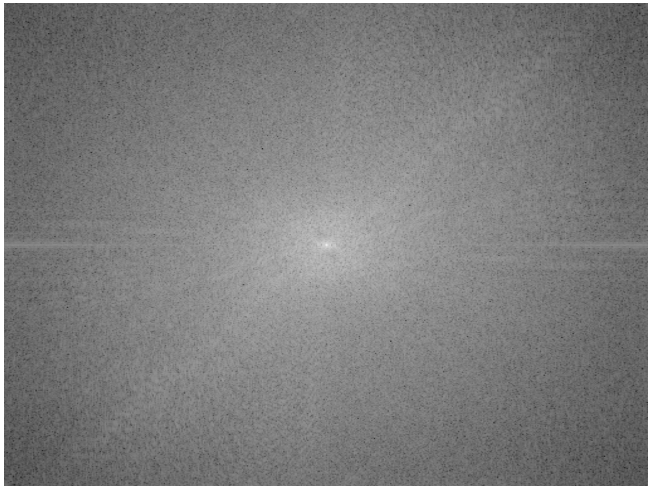
2D Fourier Transform

- Fourier Transform

$$F(u,v)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)\cdot e^{-2\pi i(ux+vy)}\,dxdy$$

- Inverse Fourier Transform

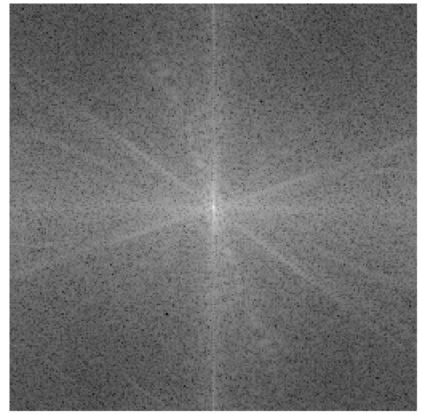
$$f(x,y)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} F(u,v)\cdot e^{2\pi i(ux+vy)}\,dudv$$



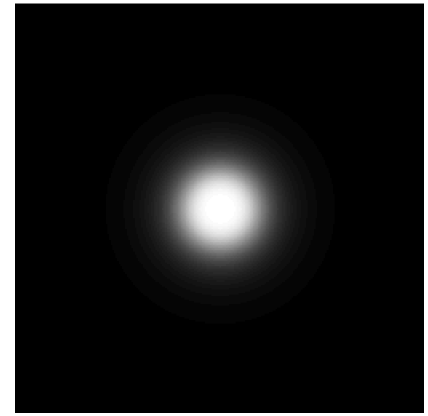
Low-pass filter

Original image

FFT of original image



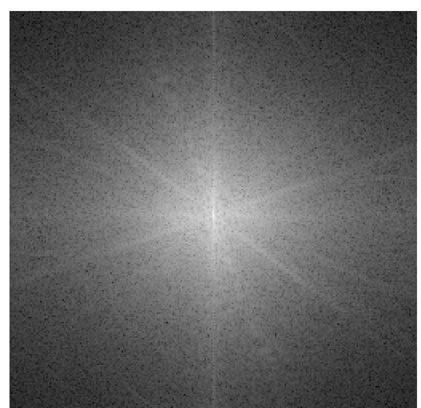
Low−pass filter



Let the low frequencies pass and eliminating the high frequencies.

Low−pass image

FFT of low−pass image

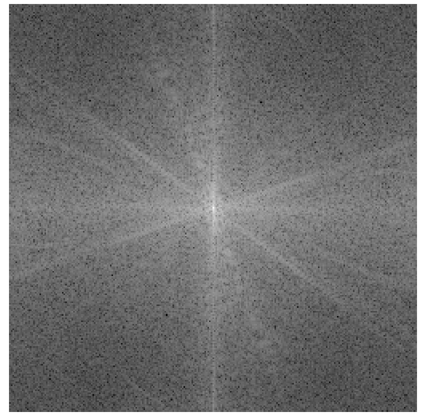


Generates image with overall
shading, but not much detail

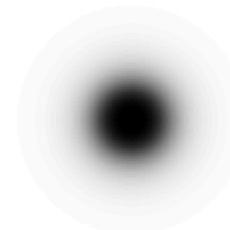
High-pass filter

Original image

FFT of original image



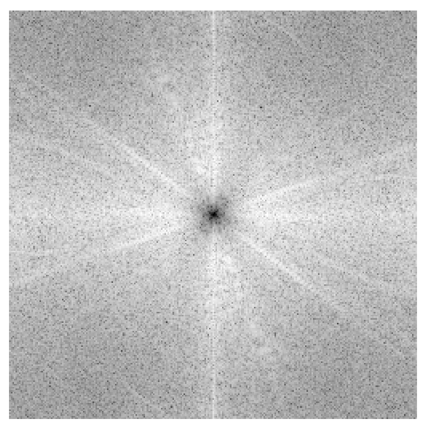
High−pass filter



Lets through the high frequencies (the detail), but eliminates the low frequencies (the overall shape). It acts like an edge enhancer.

High−pass image

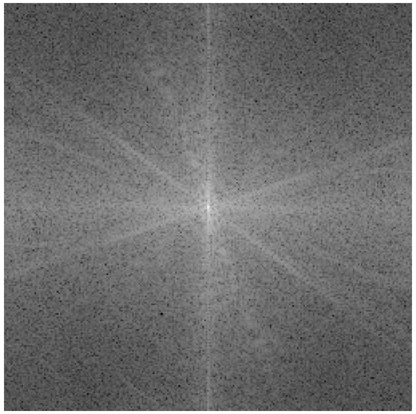
FFT of high−pass image



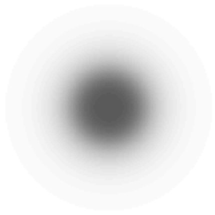
Boosting high frequencies

Original image

FFT of original image

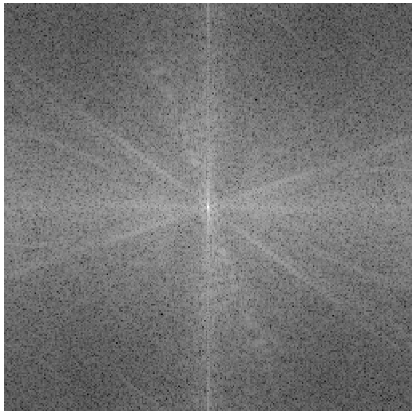


High-boost filter



High boosted image

FFT of high boosted image



Discrete Fourier Transform

- Fourier Transform

1D $$F(u)=\frac{1}{N}\sum_{x=0}^{N-1} f(x)\cdot e^{\frac{-2\pi i u x}{N}}$$

2D $$F(u,v)=\frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\cdot e^{-2\pi i\left(\frac{ux}{M}+\frac{vy}{N}\right)}$$

- Inverse Fourier Transform

1D $$f(x)=\frac{1}{N}\sum_{u=0}^{N-1} F(u)\cdot e^{\frac{2\pi i u x}{N}}$$

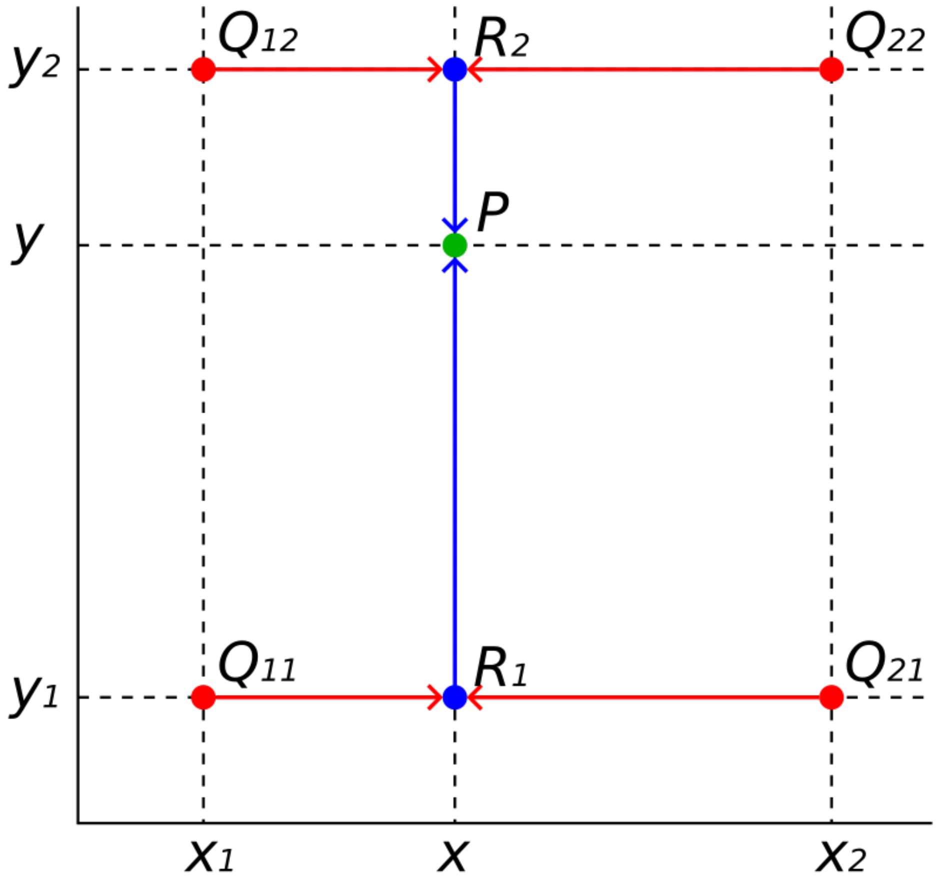
2D $$f(x,y)=\frac{1}{MN}\sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v)\cdot e^{2\pi i\left(\frac{ux}{M}+\frac{vy}{N}\right)}$$

Bi-linear Interpolation

- 4 known data points (Q_{11}, Q_{12}, Q_{21}, Q_{22}): find value at f(x,y)

$$f(x,y_1) = \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}),$$
$$f(x,y_2) = \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}).$$

$$f(x,y) = \frac{y_2 - y}{y_2 - y_1} f(x,y_1) + \frac{y - y_1}{y_2 - y_1} f(x,y_2)$$



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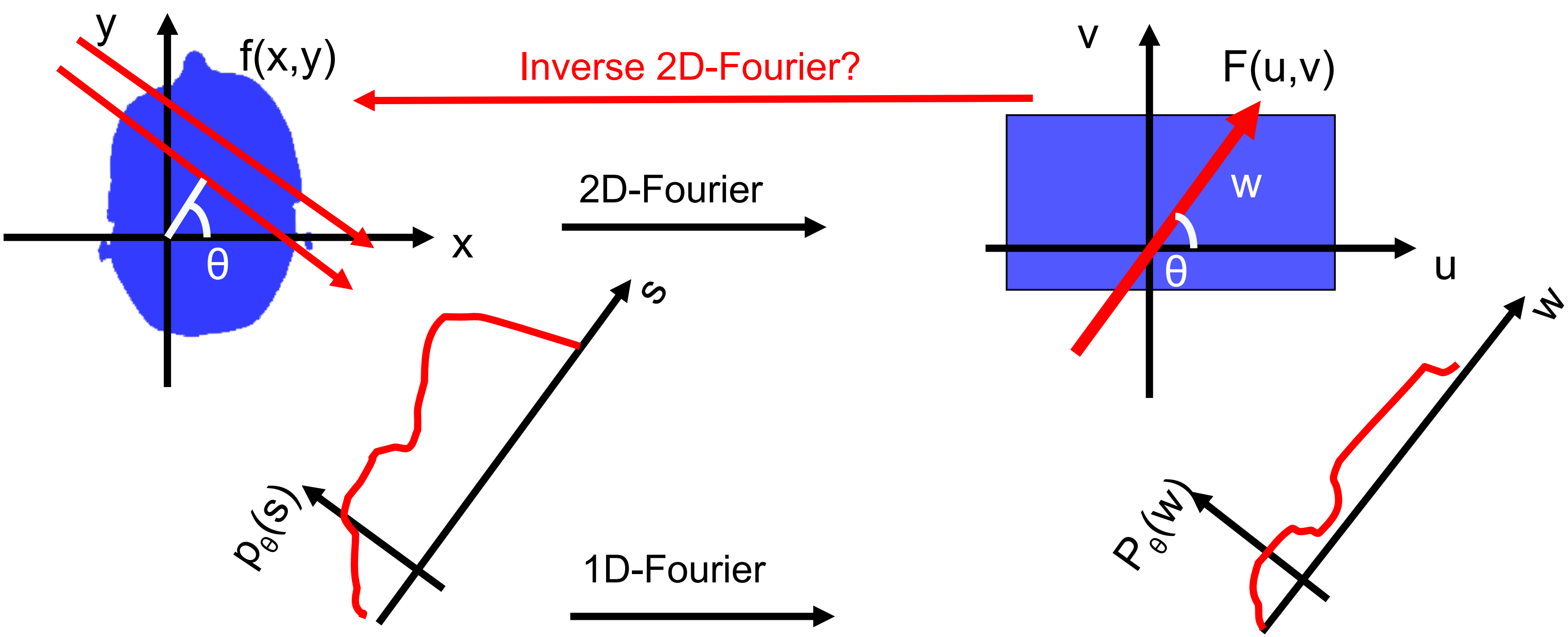
Reminder
Fourier
Reconstruction

Fourier Slice Theorem

Fourier Slice Theorem (general angle θ)



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