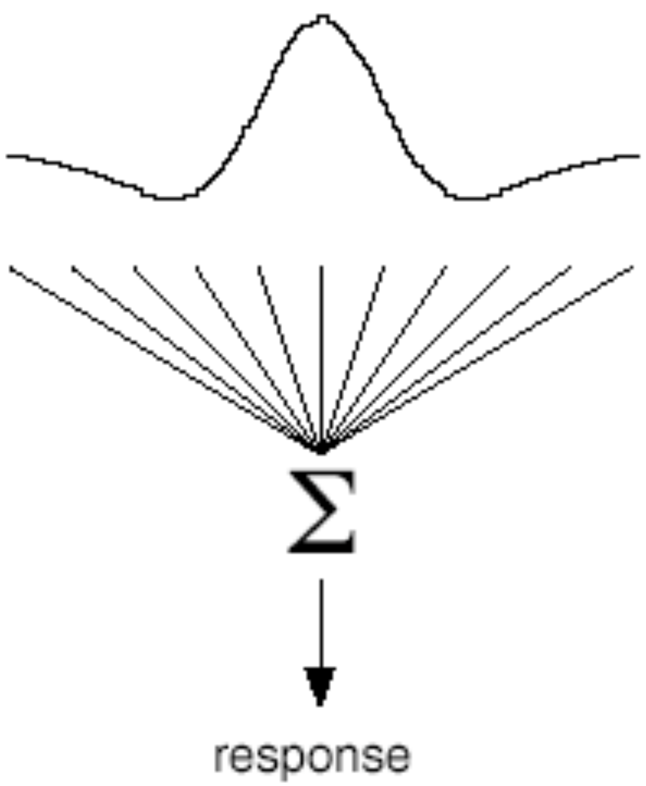
I. LNLN model of MT

(an elaboration of Tony's description)

II. Bayes motion estimation

Simple Models of RGC Light Response

linear (L)



[from EJ's talk]

Simple Models of RGC Light Response

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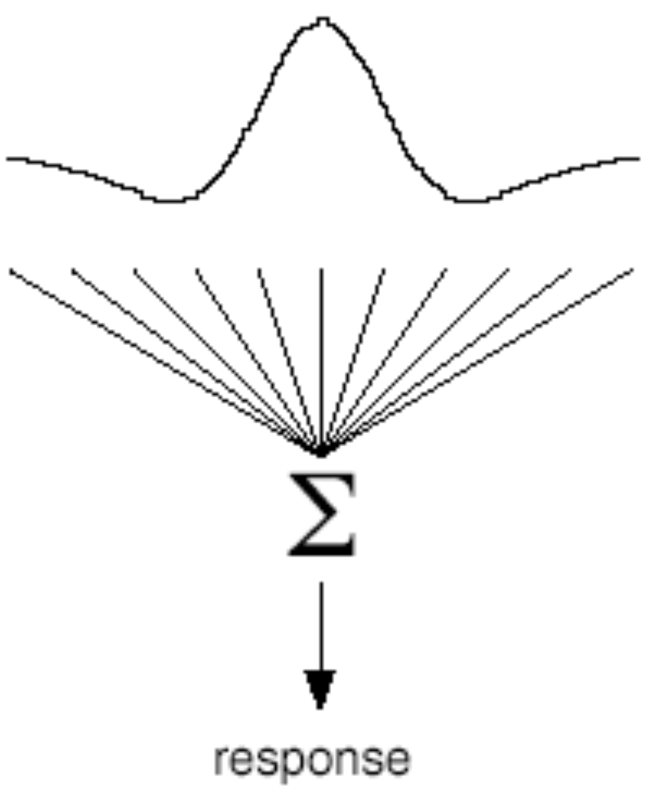
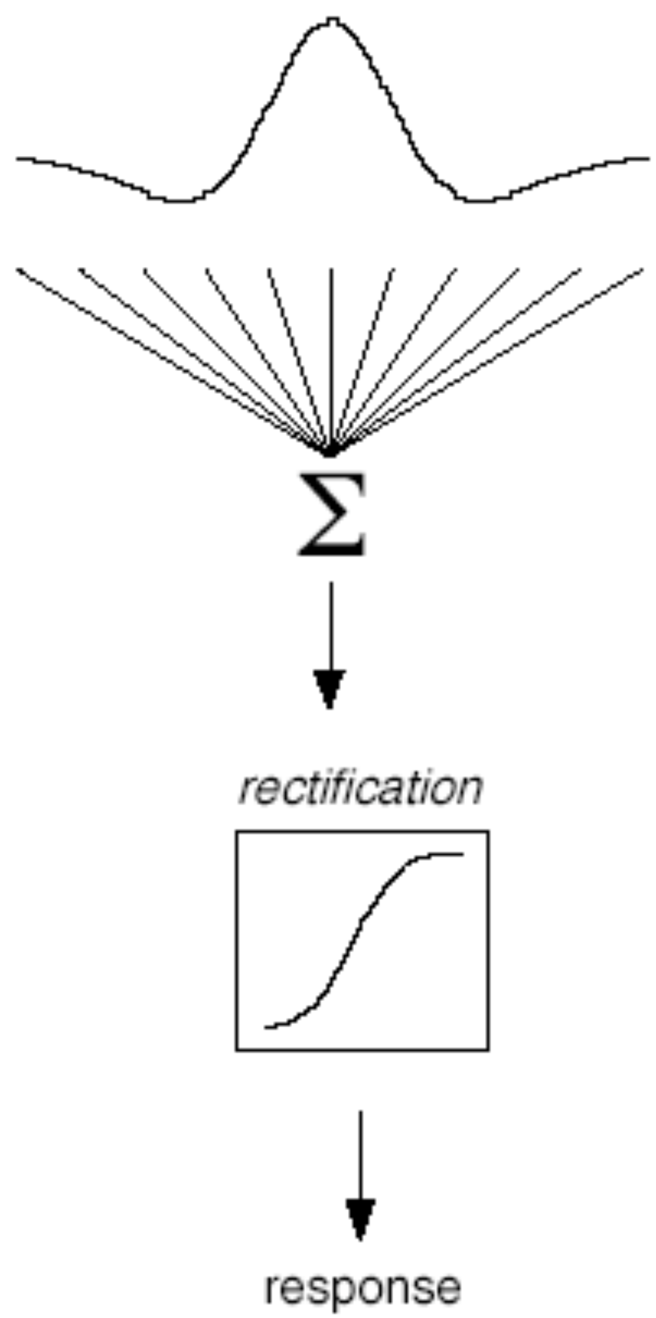


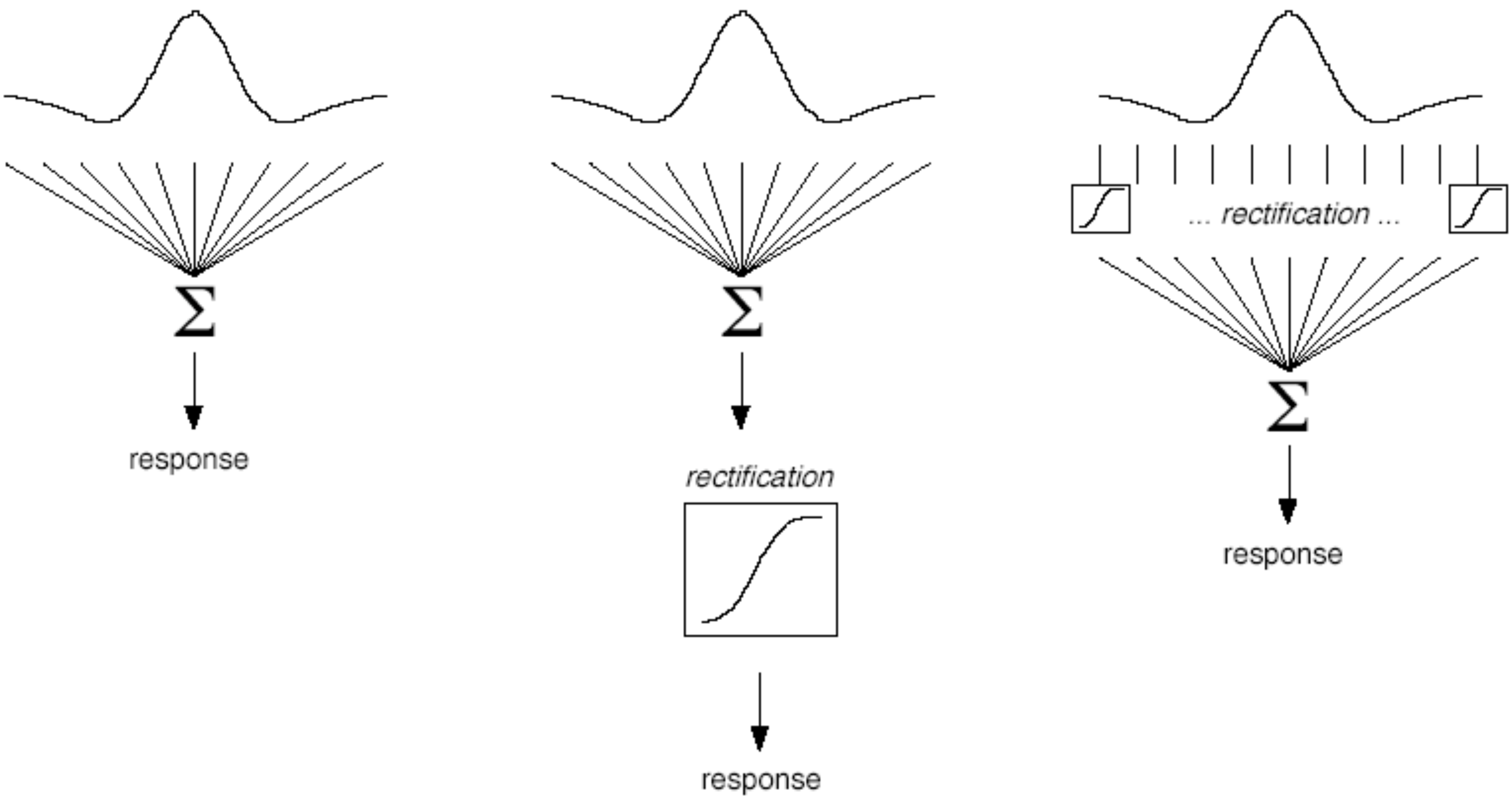
simple nonlinearity (LN)



[from EJ’s talk]

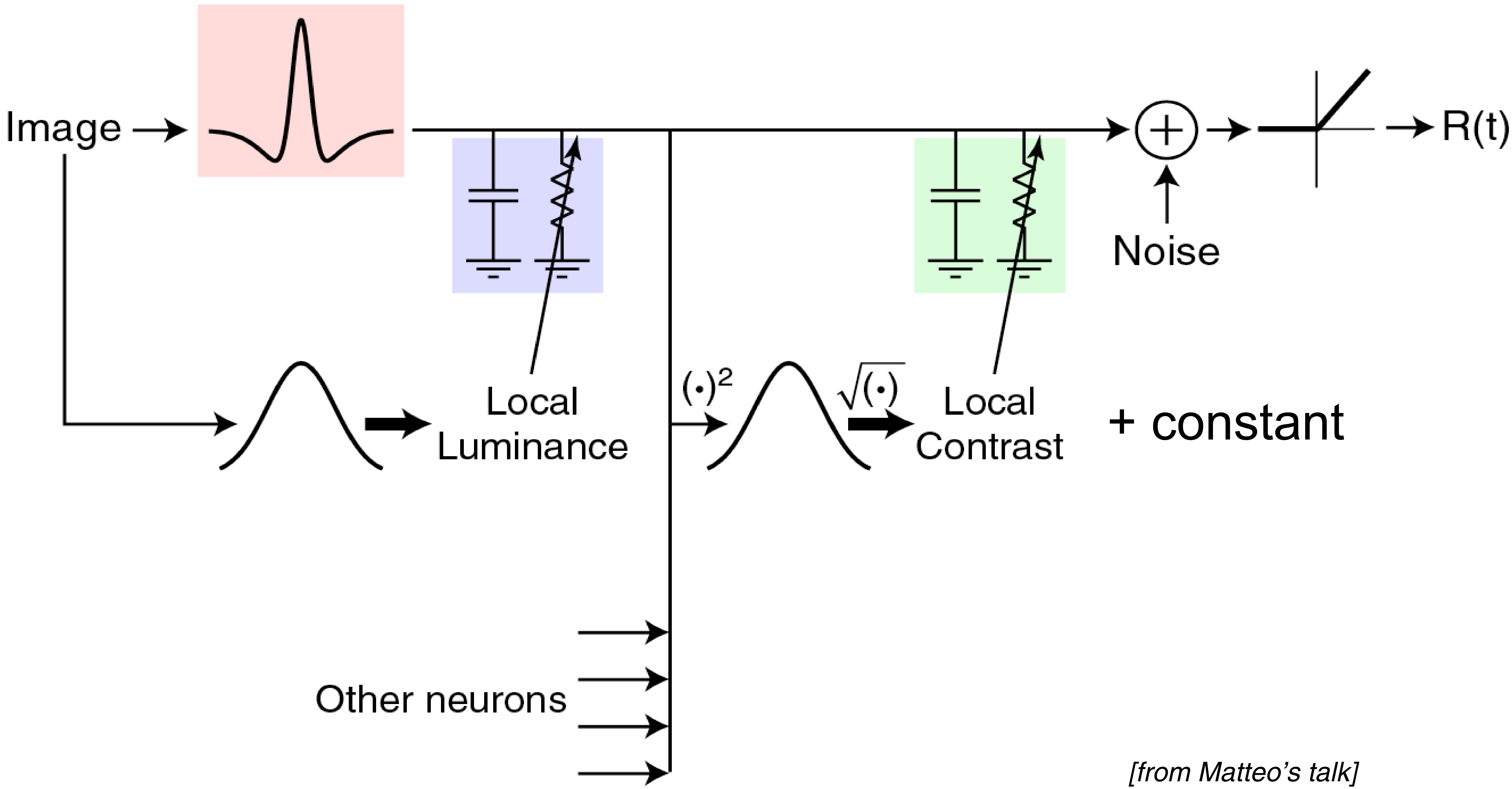
Simple Models of RGC Light Response

linear (L) | simple nonlinearity (LN) | subunits (LNL)



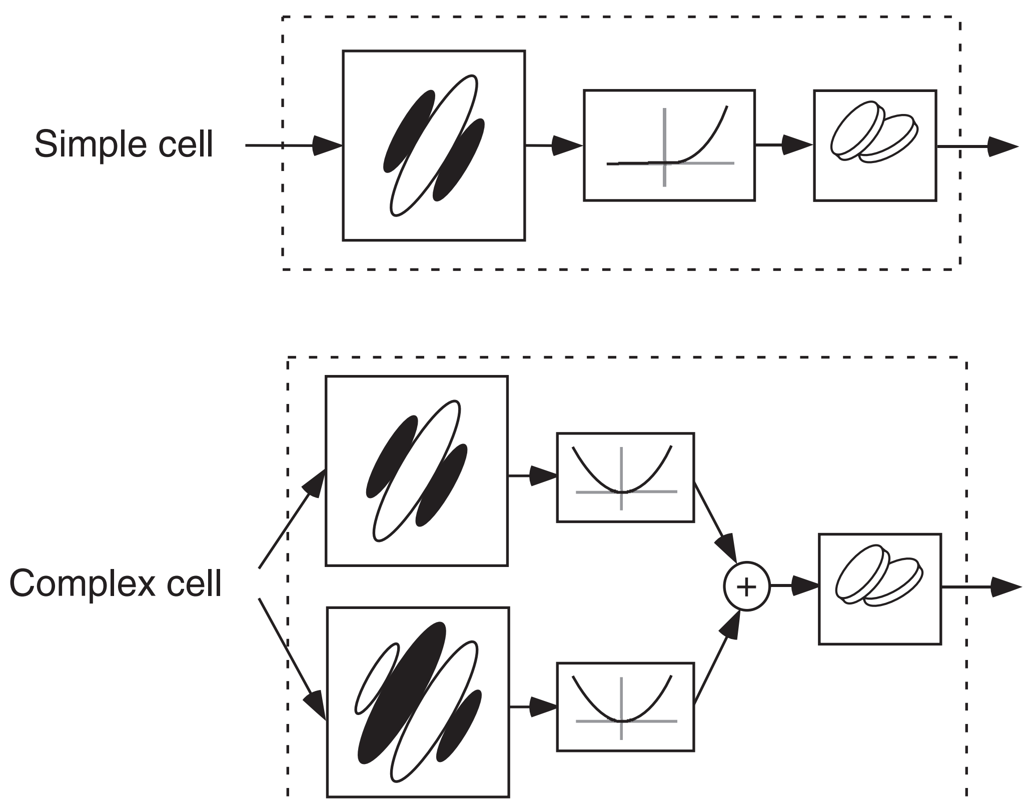
[from EJ's talk]

LGN model



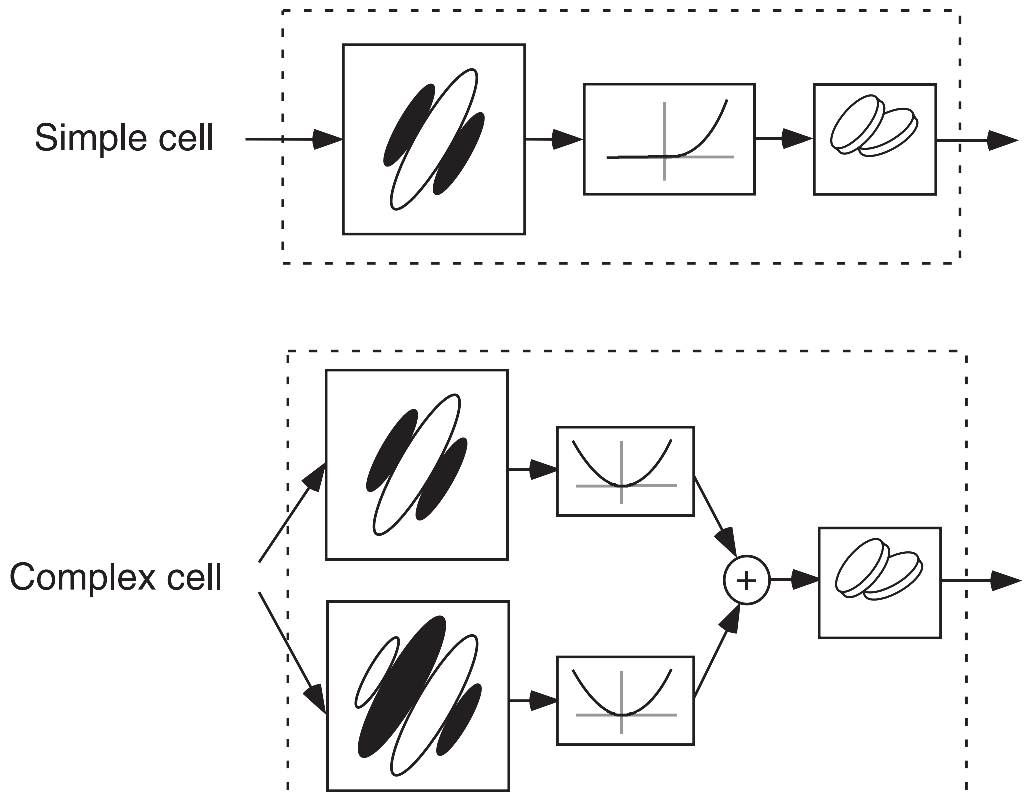
[from Matteo's talk]

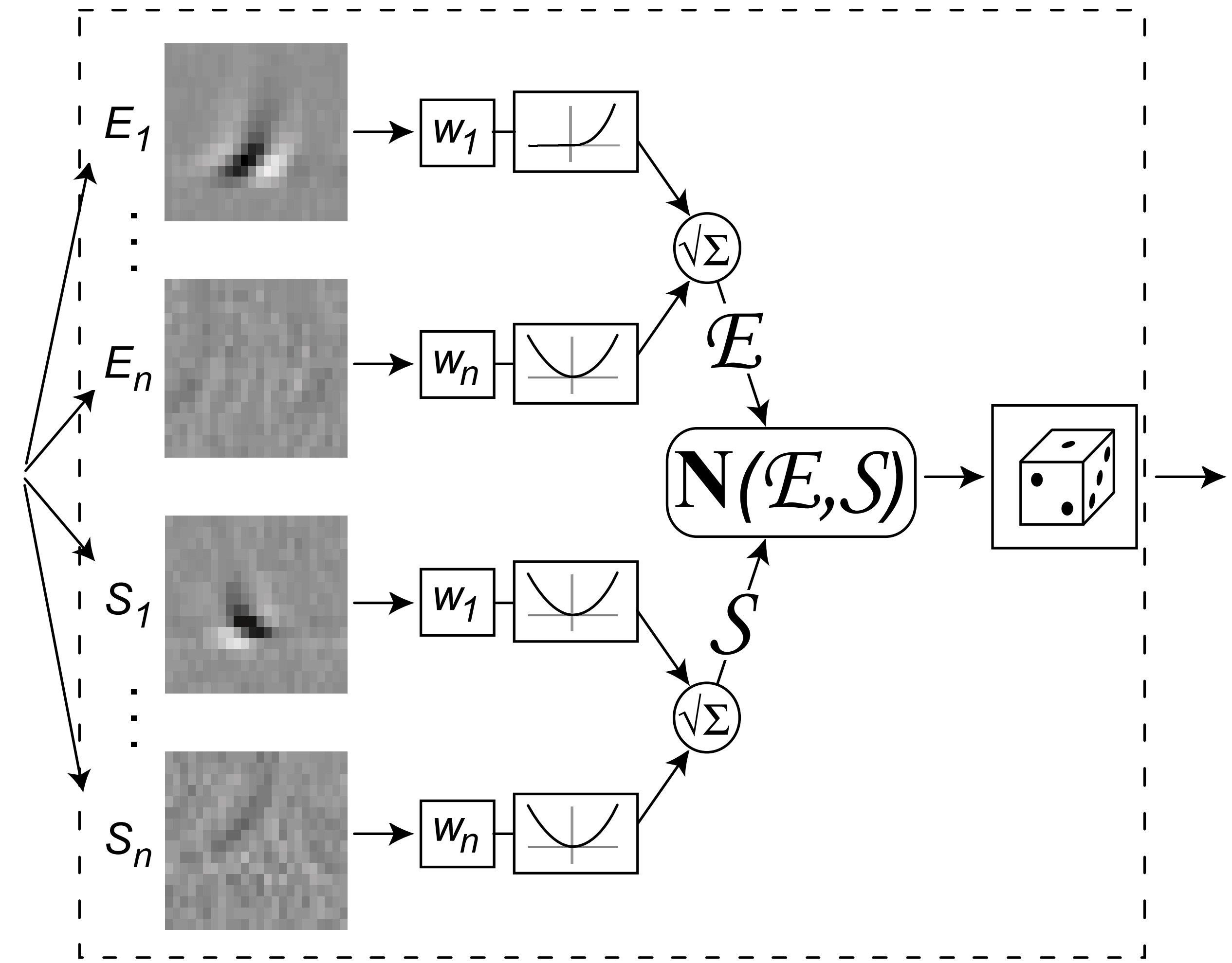
V1 models



[from Nicole's talk]

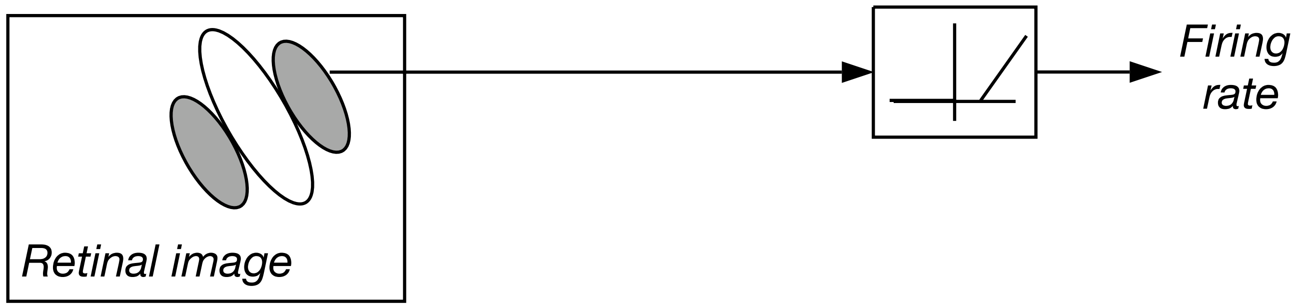
V1 models



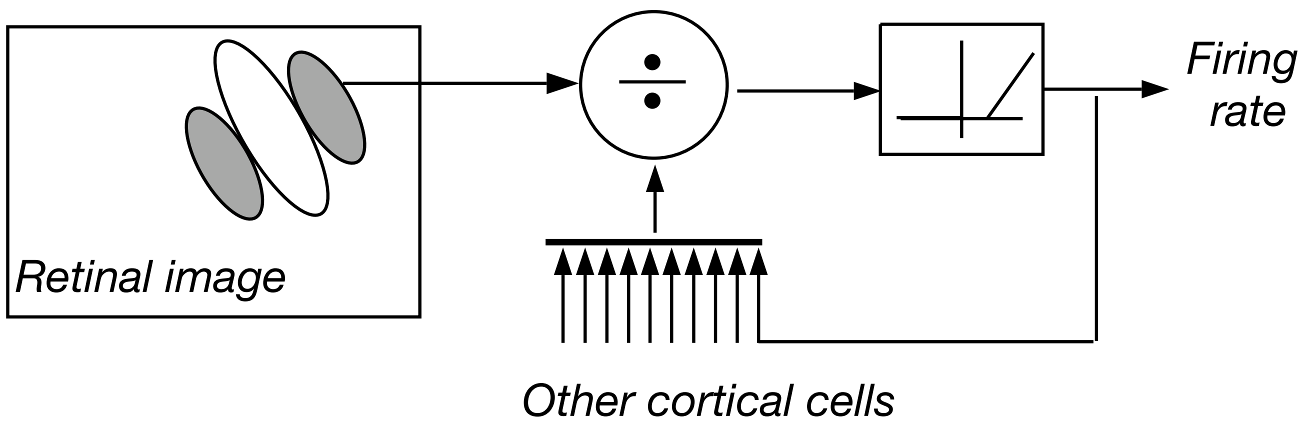


[from Nicole's talk]

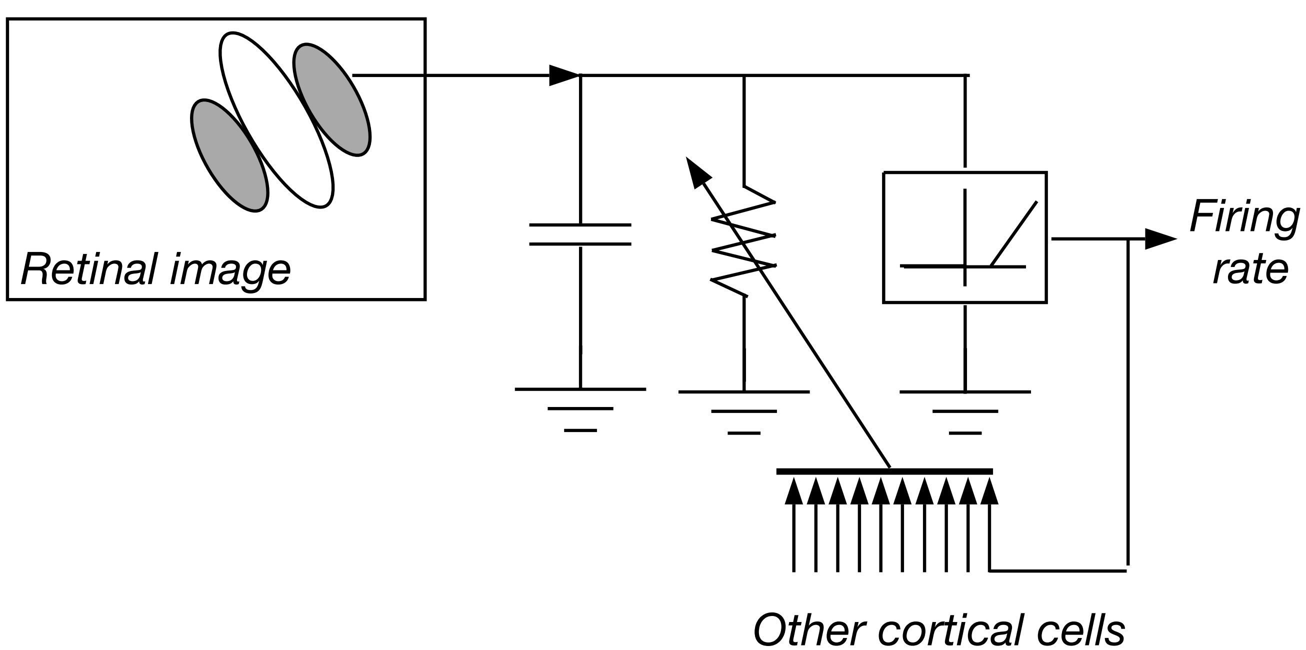
The linear model of simple cells



The normalization model of simple cells



RC circuit implementation



Carandini, Heeger, and Movshon, 1996

Models so far....

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  - "Point" (a.k.a. memoryless or static) nonlinearities
  - Modulatory: Gain control / Divisive normalization
- Cascades
- This "toolbox" is surprisingly effective. How far can we go with it?

Obviously missing:
Recurrent processing

- Within single neurons: Spike generation (e.g., refractoriness, spike rate adaptation)
- Lateral connectivity
- Feedback connectivity

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Recurrent processing

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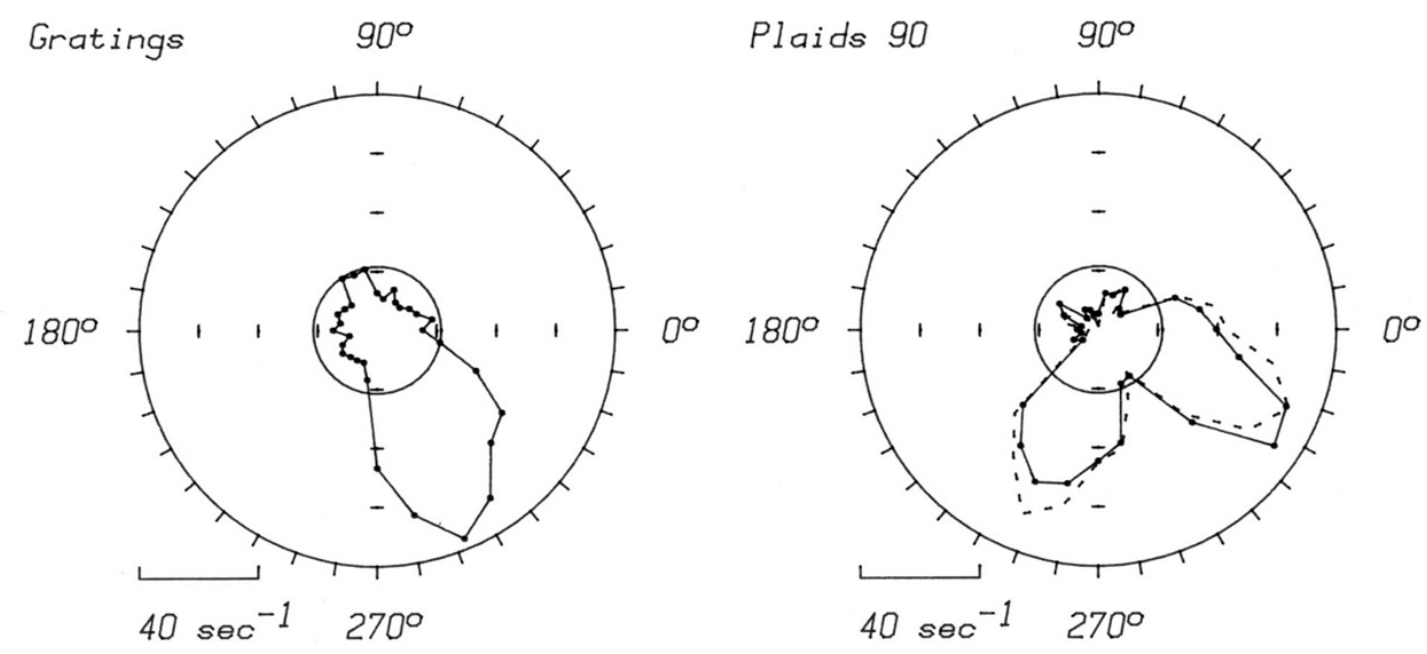
Note: despite their existence and potential functional importance, these are much harder to understand and model, and are often underconstrained by existing experimental data (my opinion).

A striking nonlinearity

V1 cell

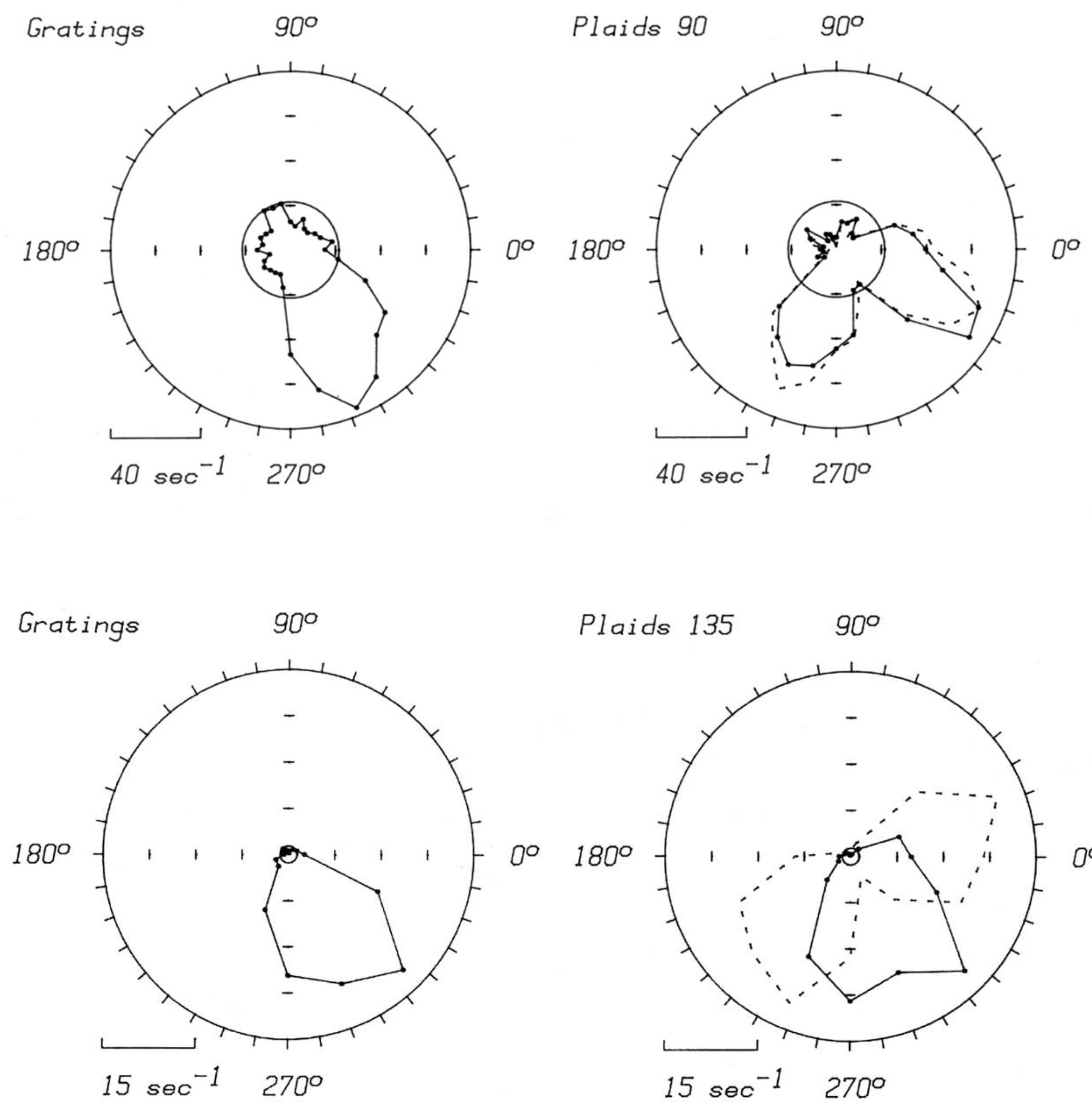


Movshon etal, 1985

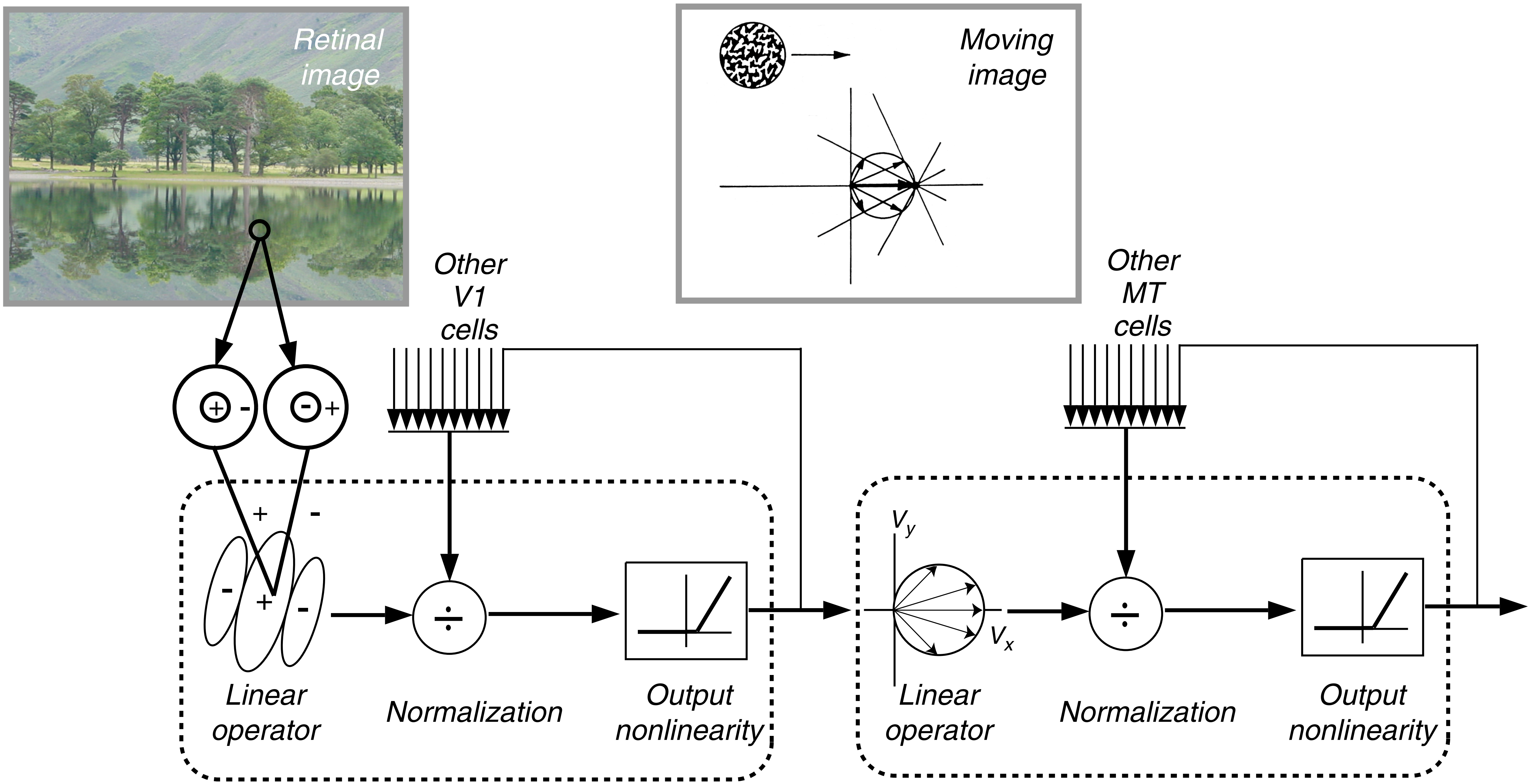
A striking nonlinearity

V1 cell

MT pattern cell



Movshon etal, 1985

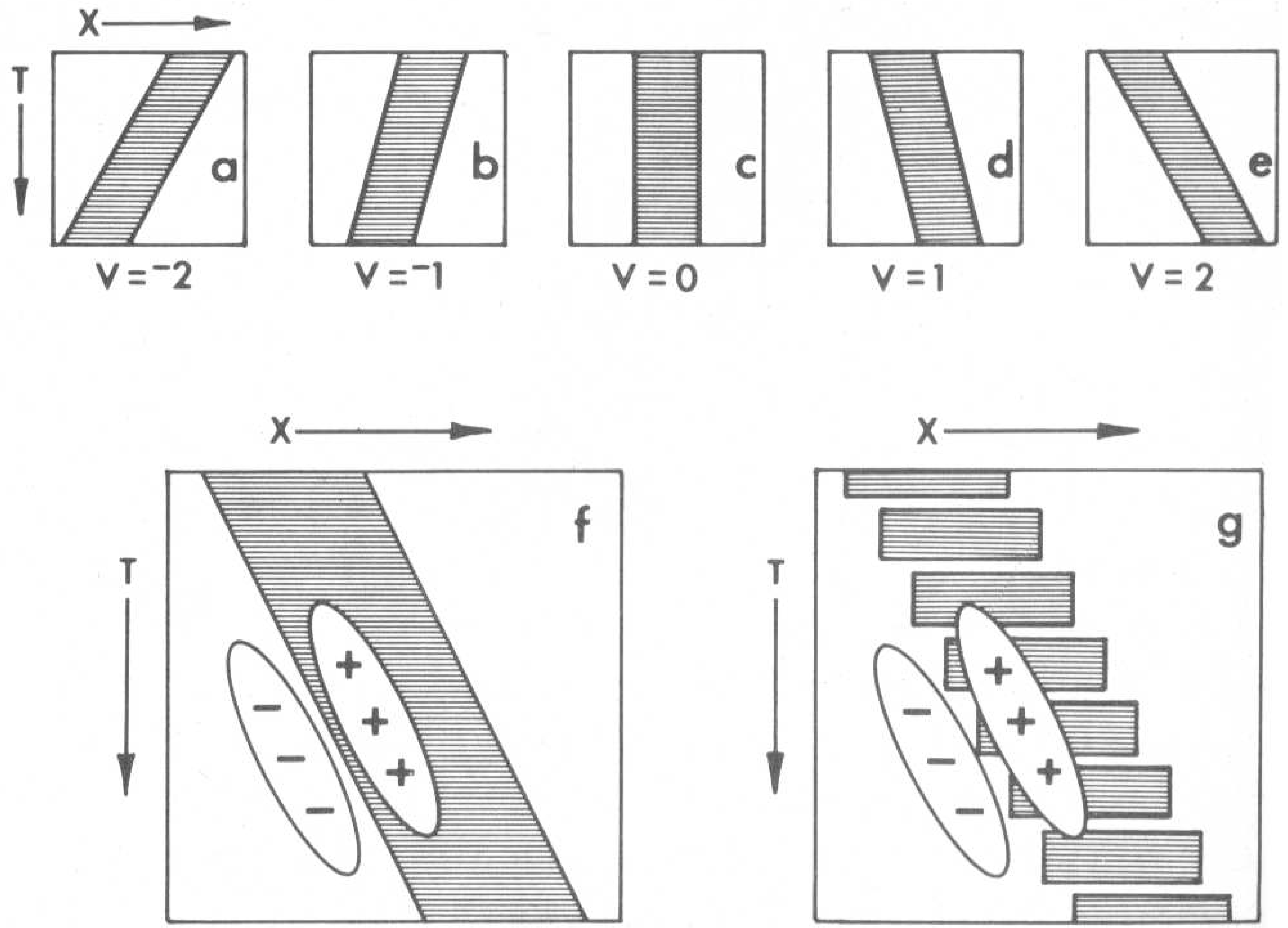


[from Tony's talk]

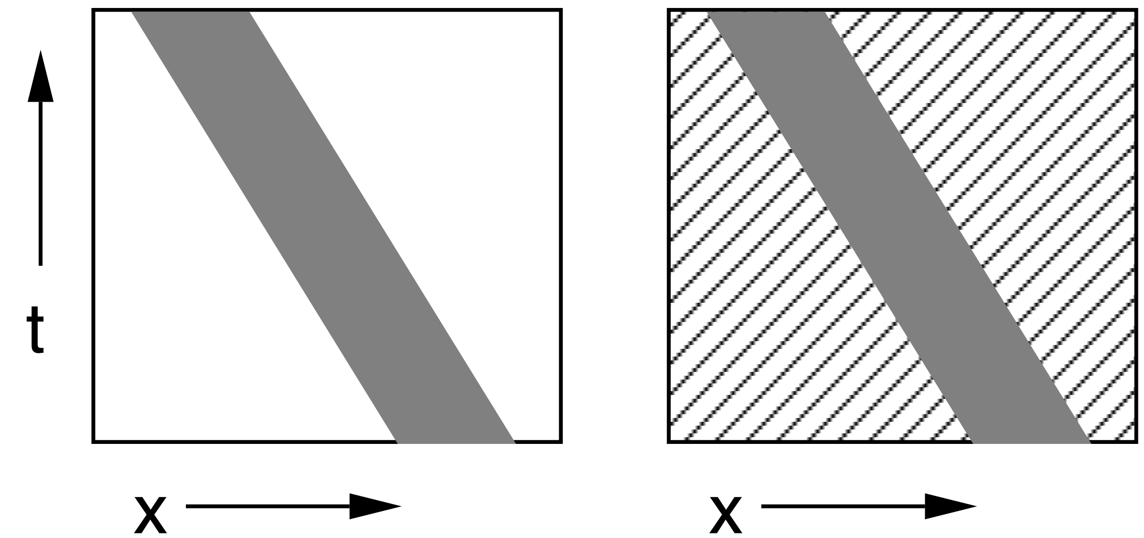
the "trick"

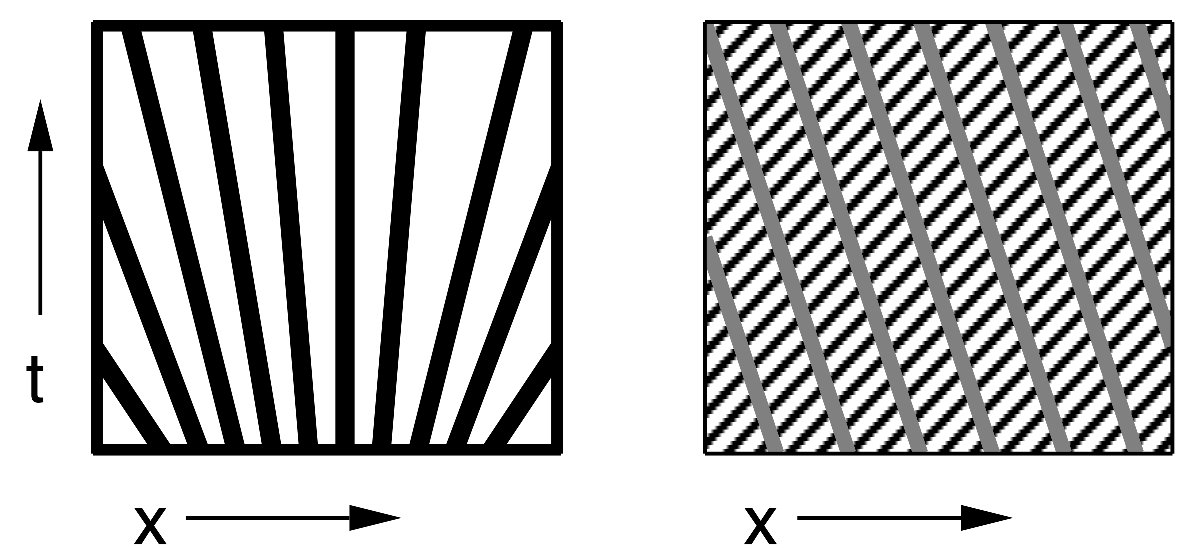
Find a way to describe pattern motion selectivity as a linear problem

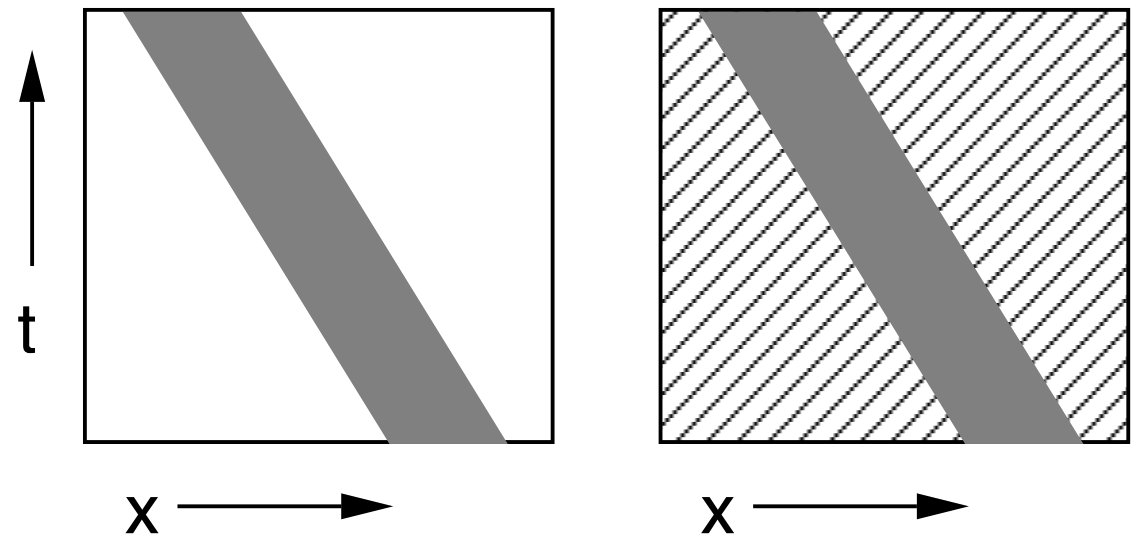
Motion is space-time orientation



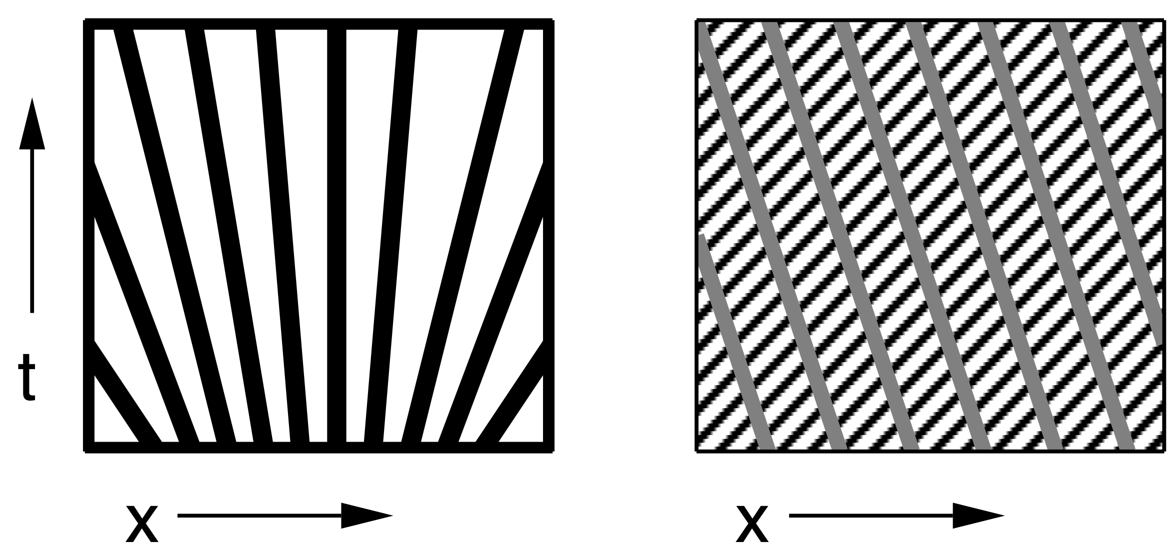
Adelson & Bergen, 1985

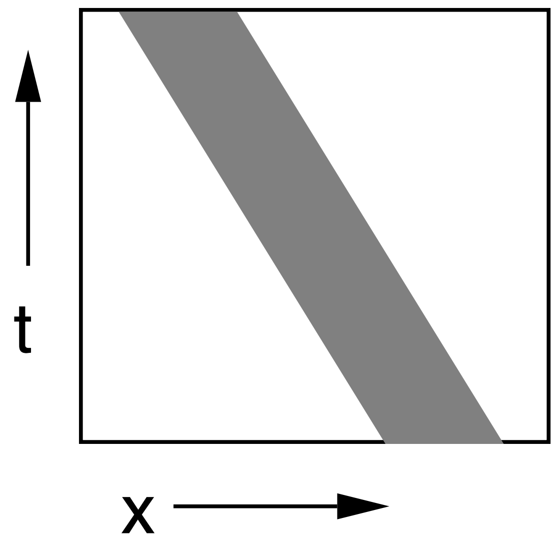

t
x
x

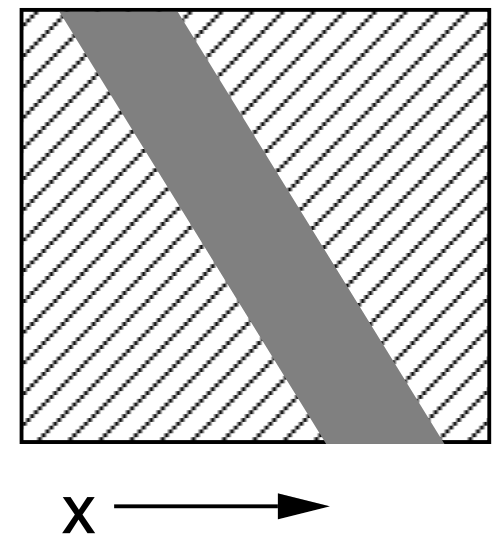

t
x
x



White background,
Gray bar,
translating left

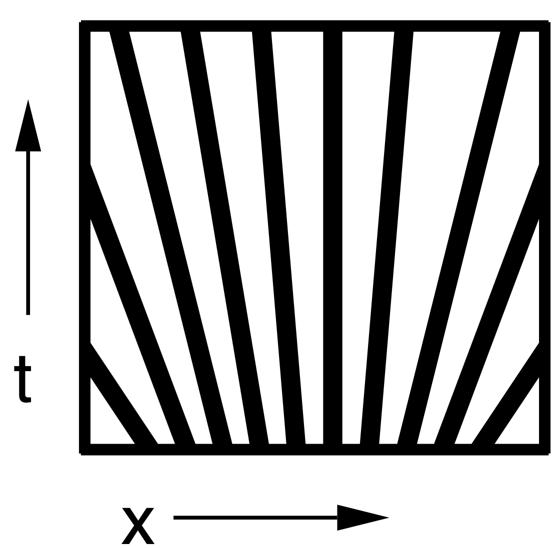


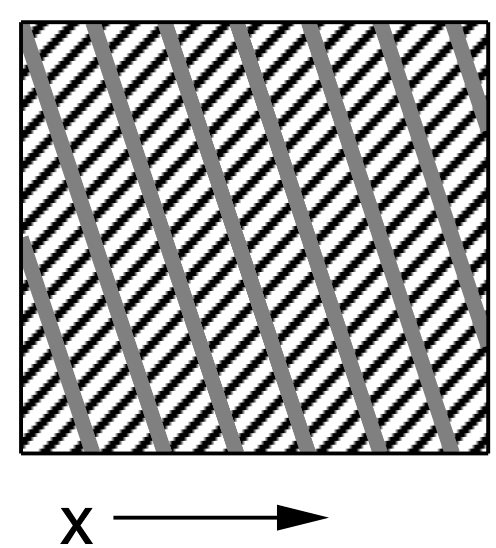


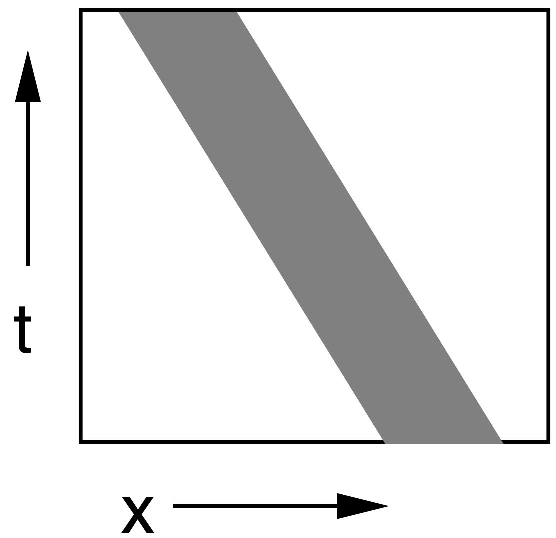


White background,
Gray bar,
translating left

Bar translating left,
occluding a striped
background moving right







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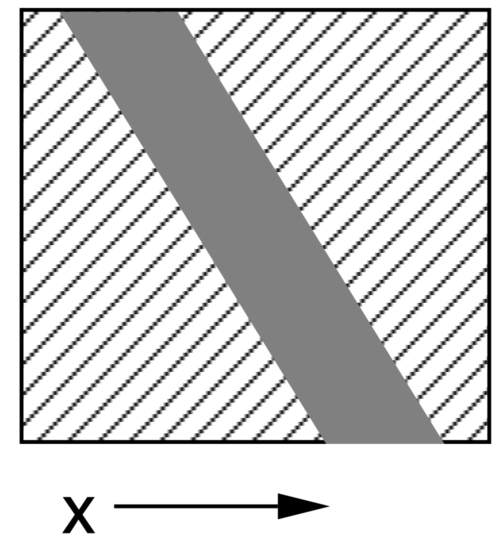

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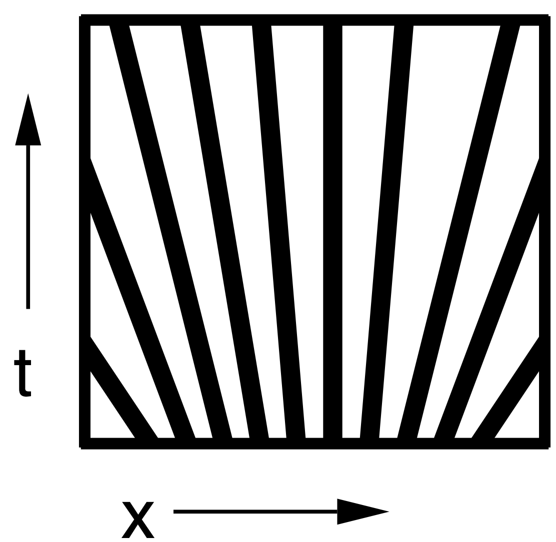
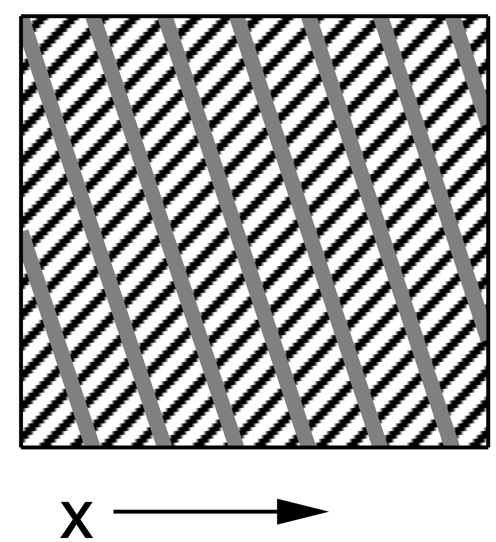
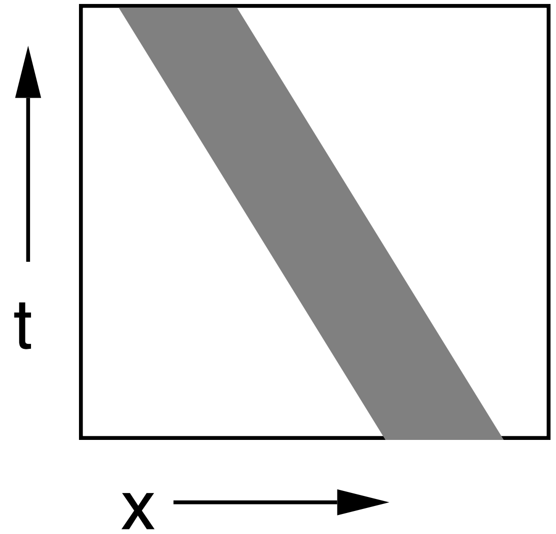


Striped background,
looming





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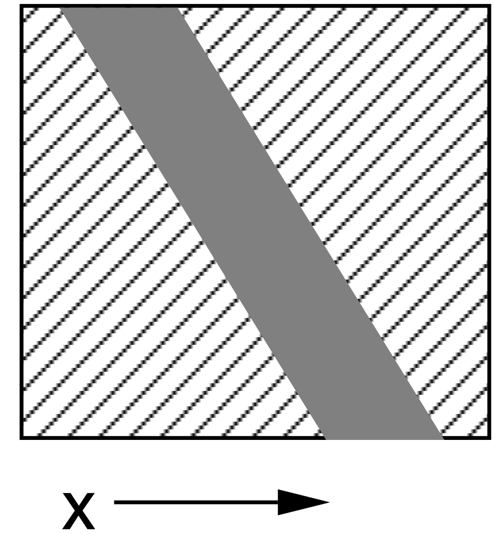

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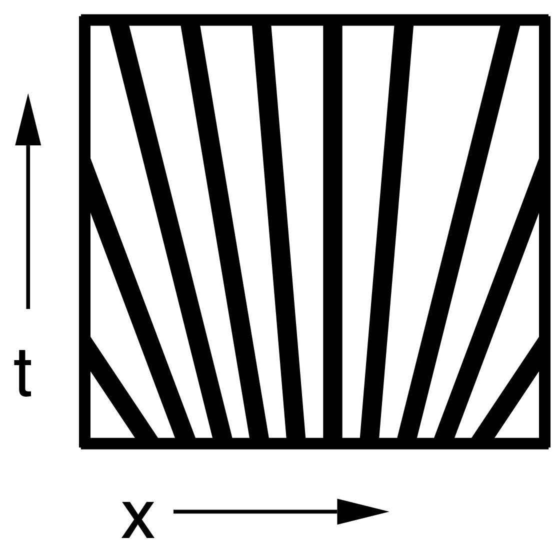

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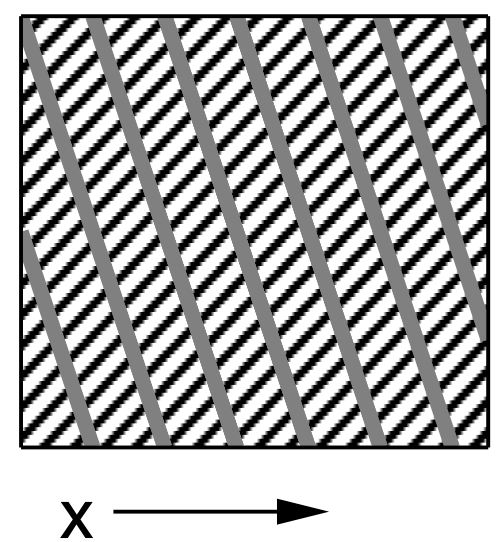
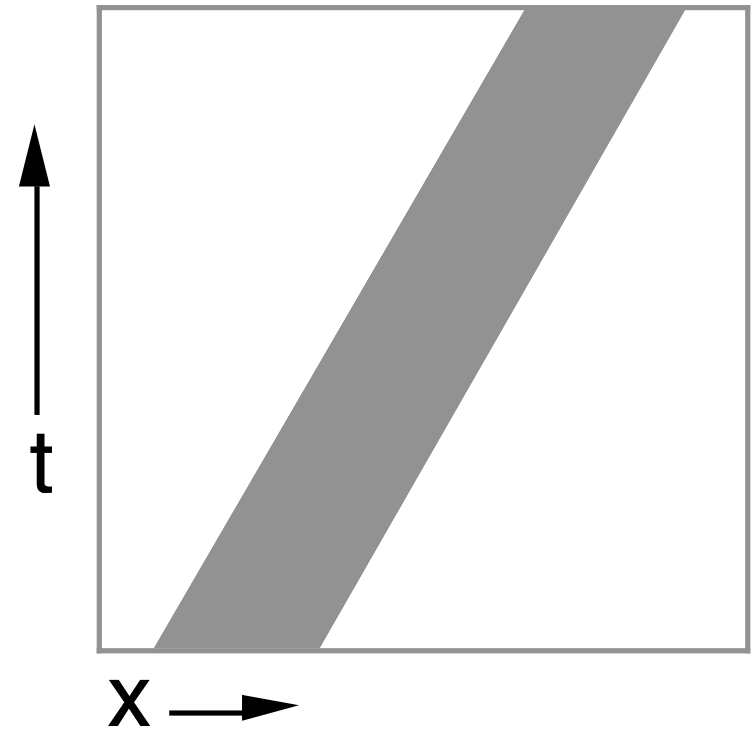
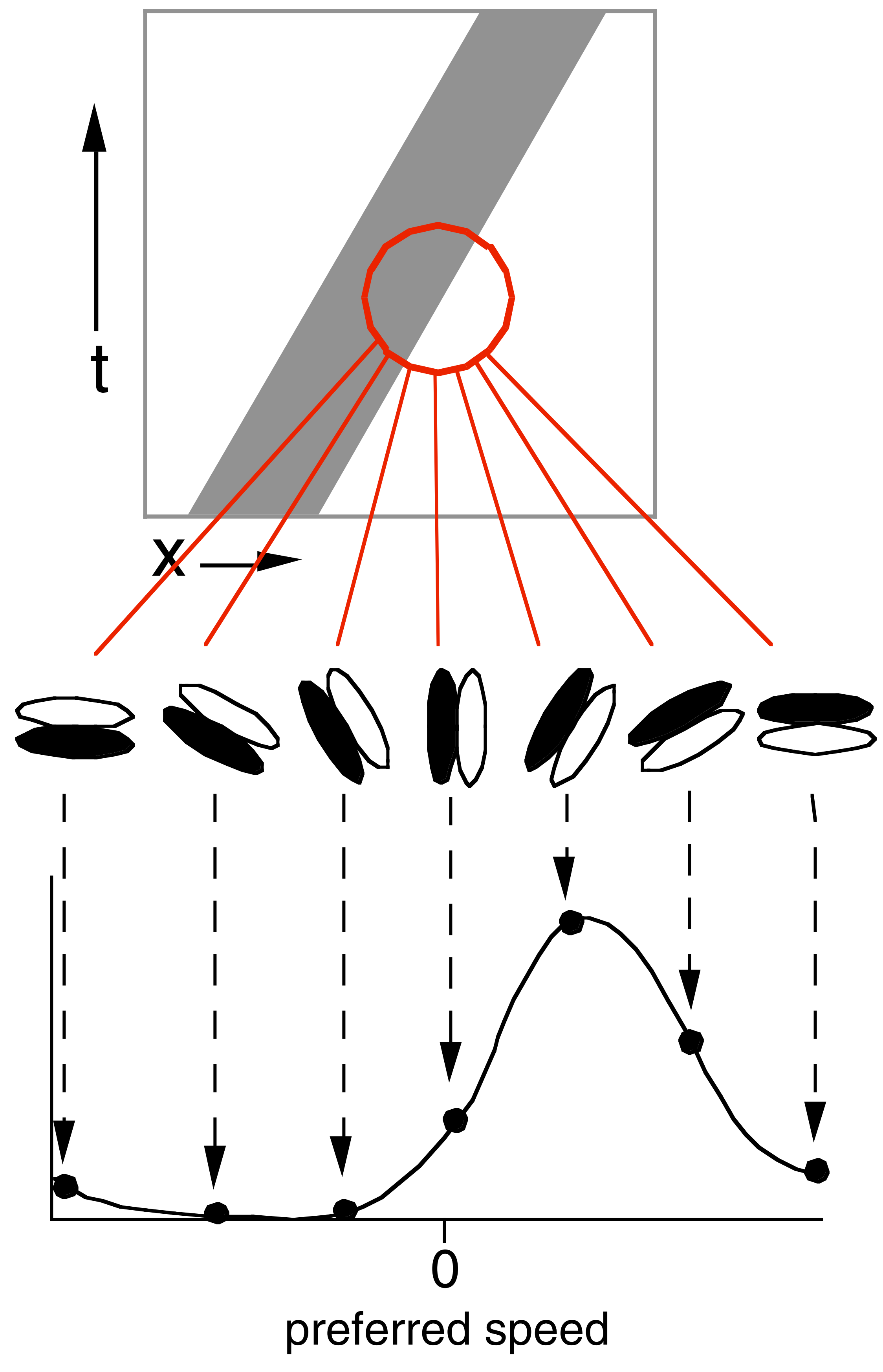
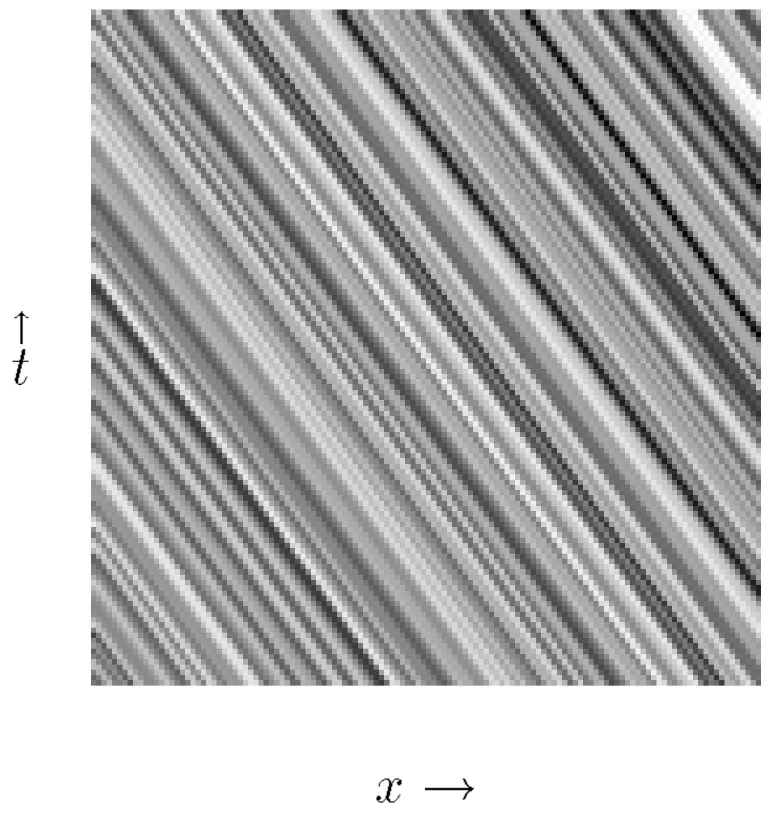


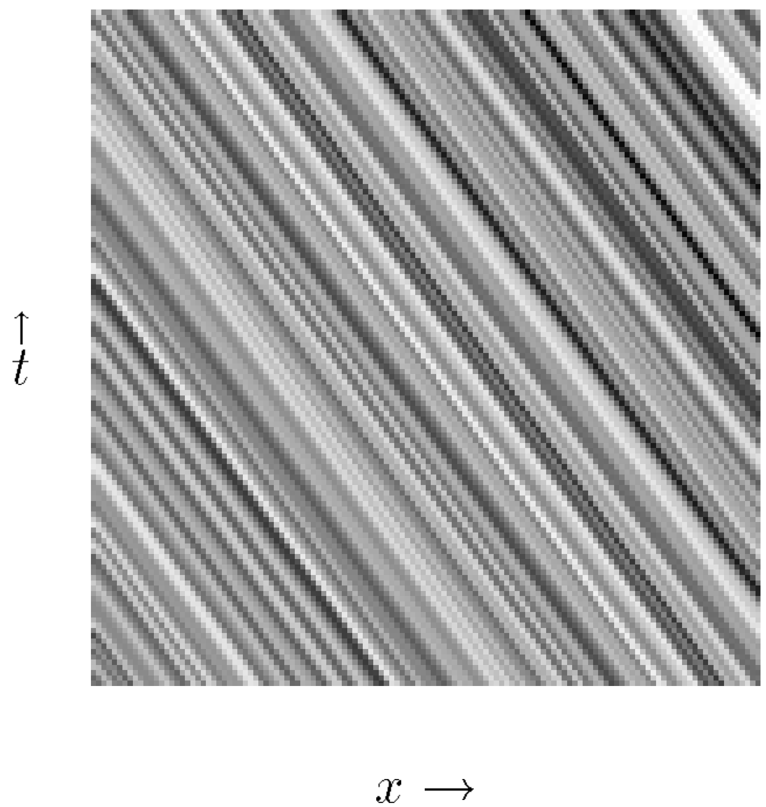
Transparently overlayed
stripe patterns, moving
in opposit directions


t
x

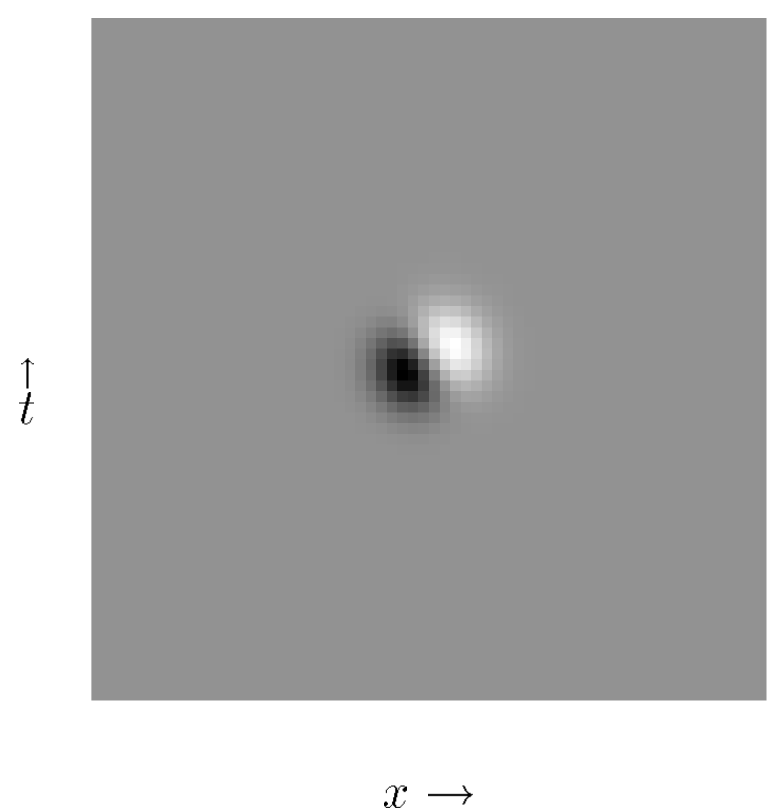
Population code



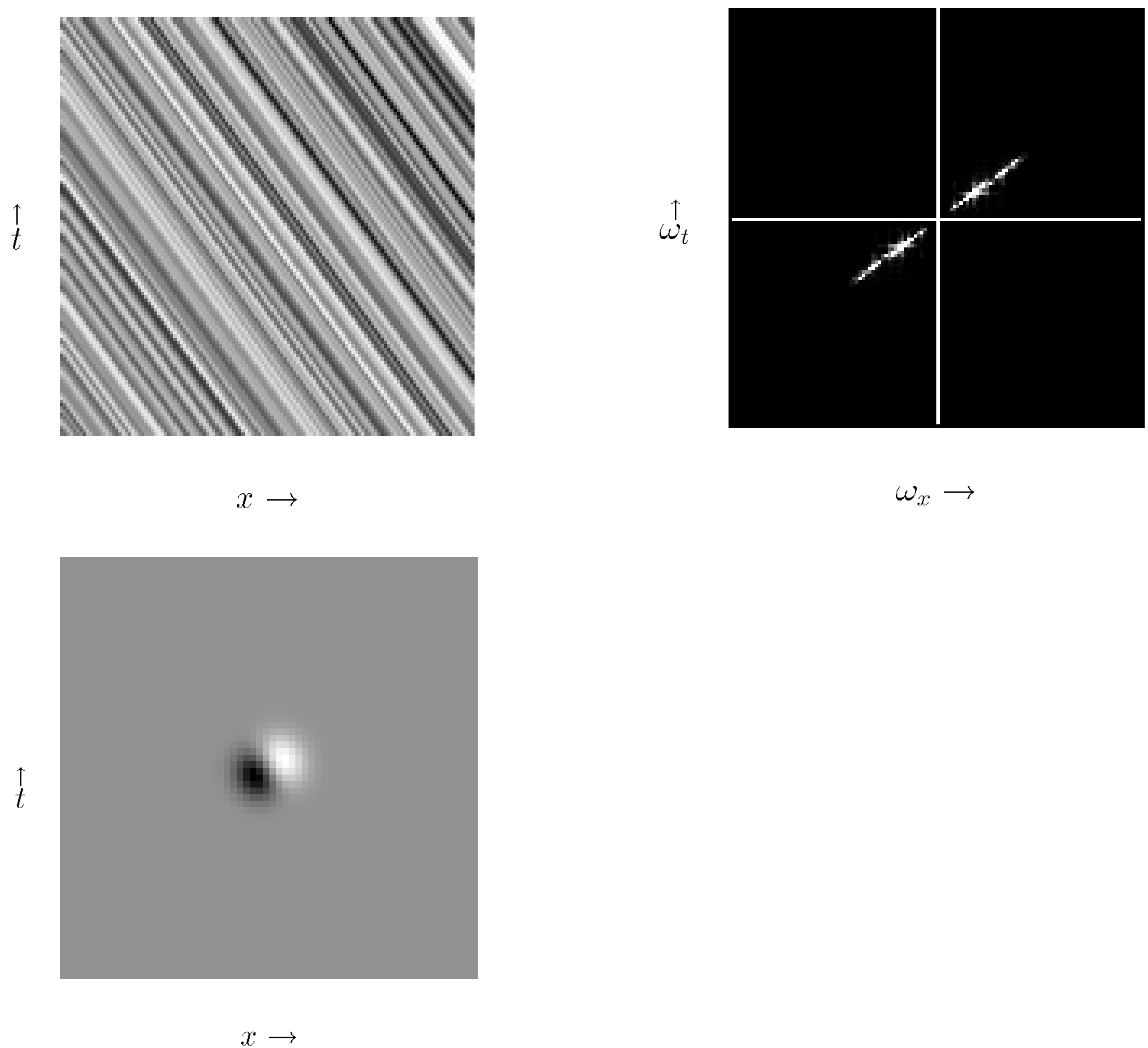




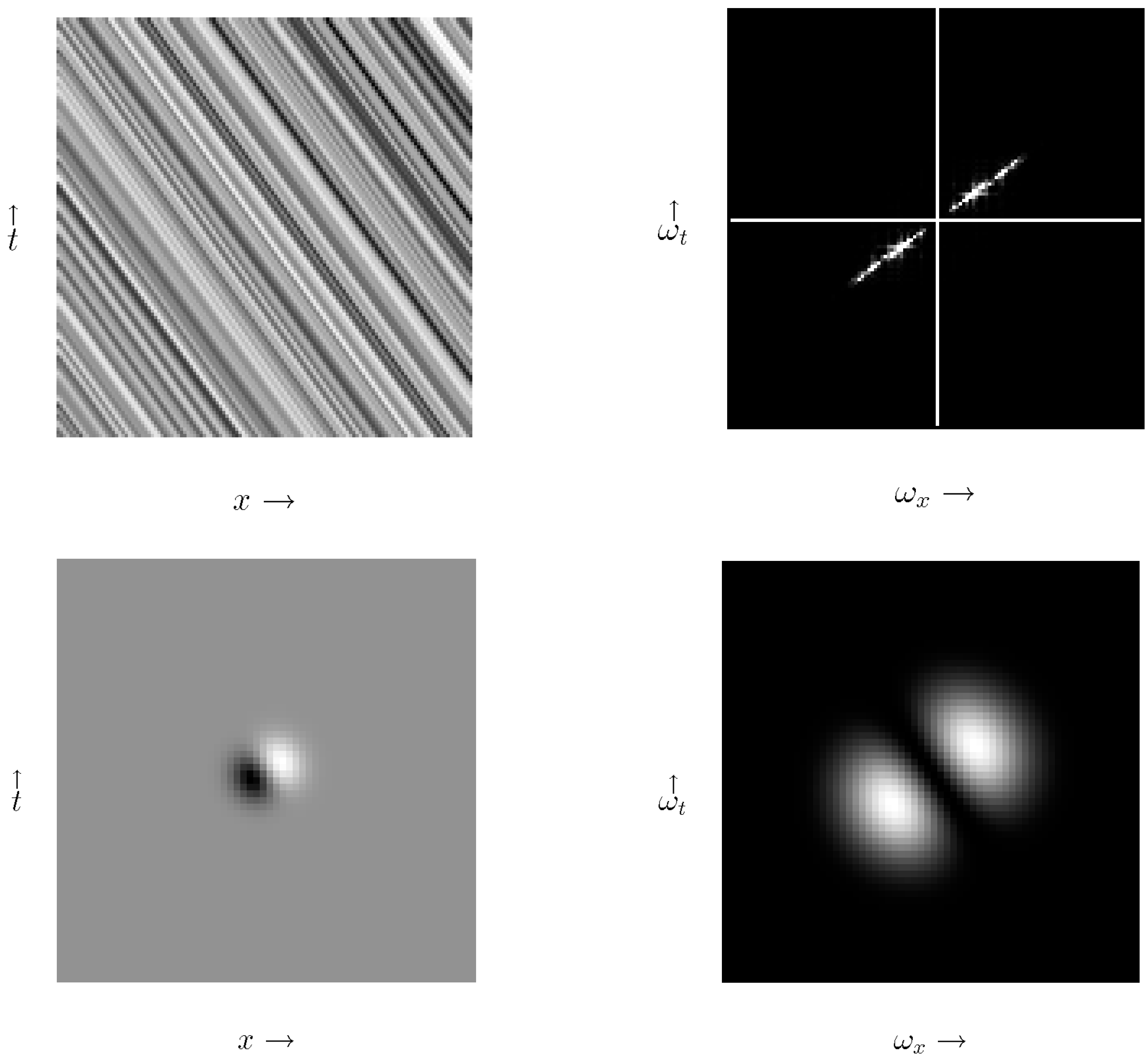
$\uparrow$
t
$x \rightarrow$



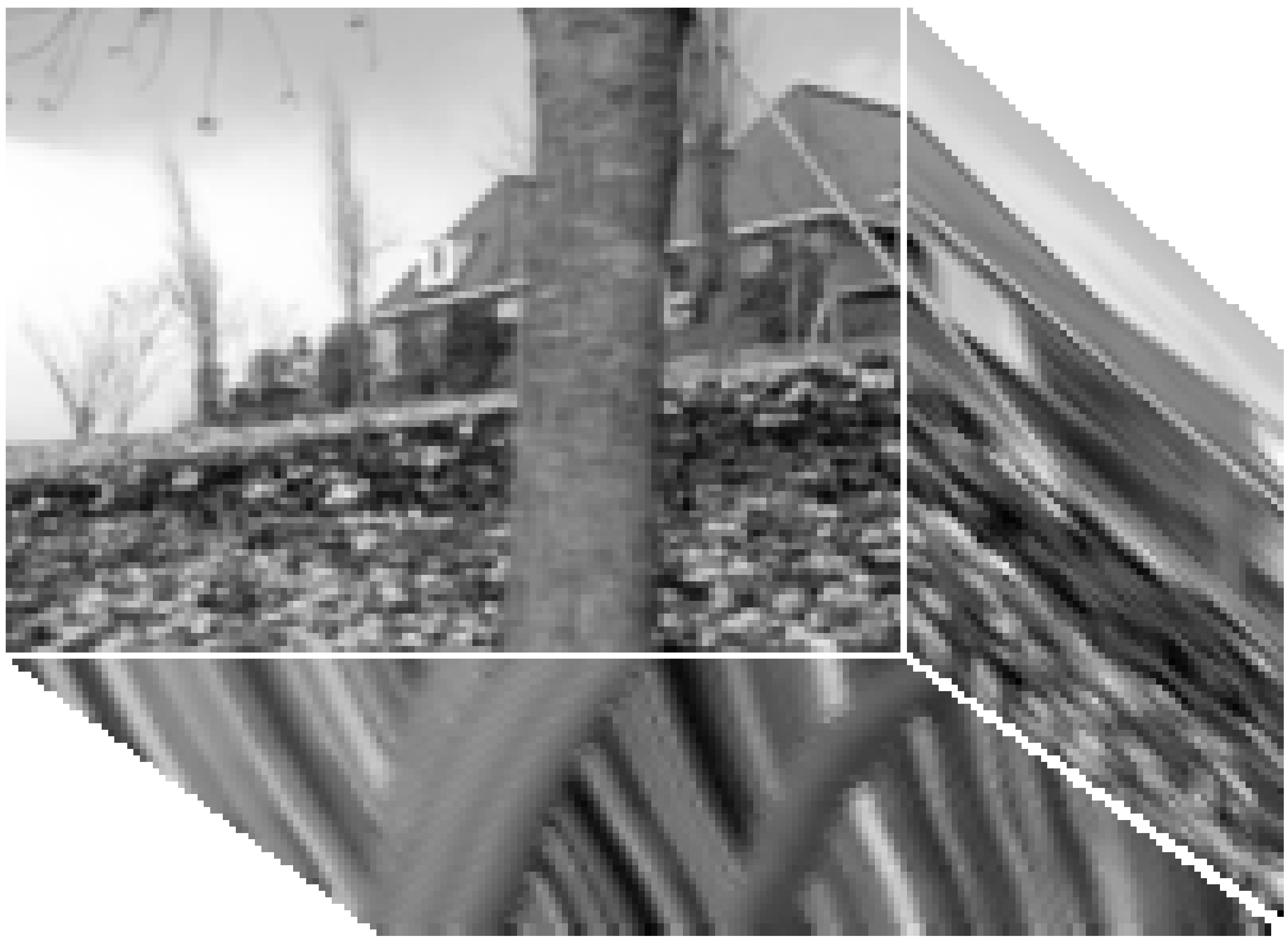
$\uparrow$
t
$x \rightarrow$

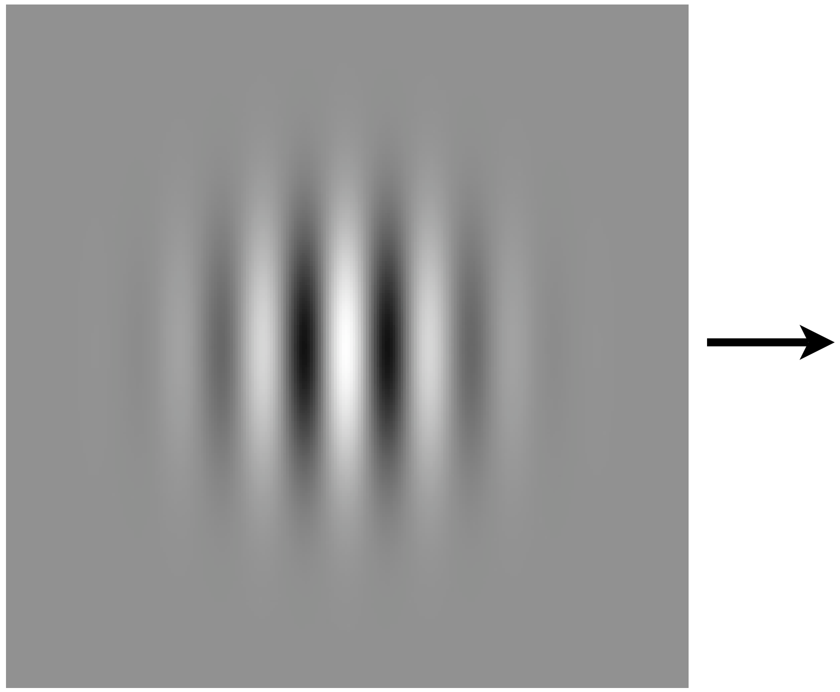


$\uparrow$ t
$x \longrightarrow$
$\uparrow$ ω_t
$\omega_x \longrightarrow$
$\uparrow$ t
$x \longrightarrow$

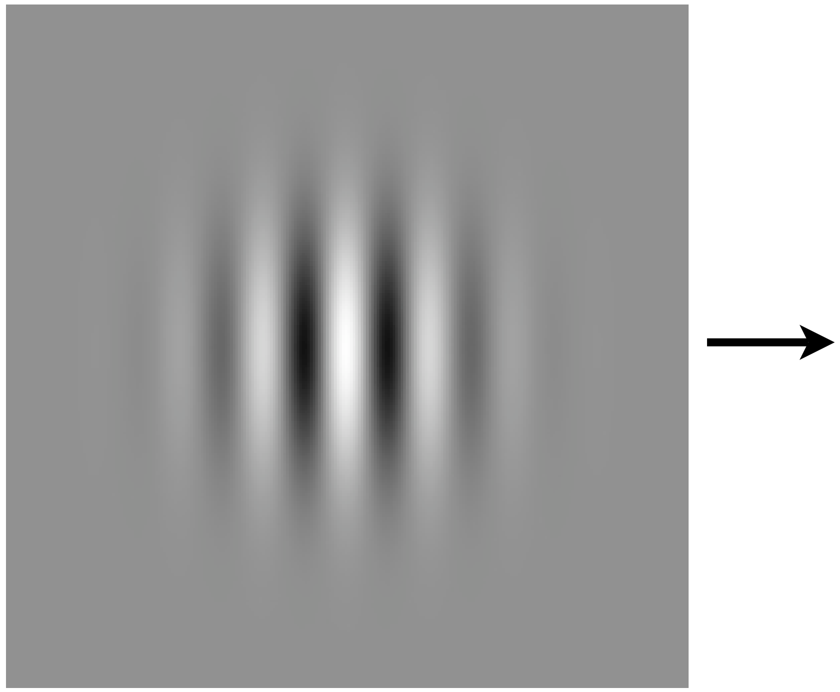

t
$x \rightarrow$
ω_t
$\omega_x \rightarrow$
t
$x \rightarrow$
ω_t
$\omega_x \rightarrow$

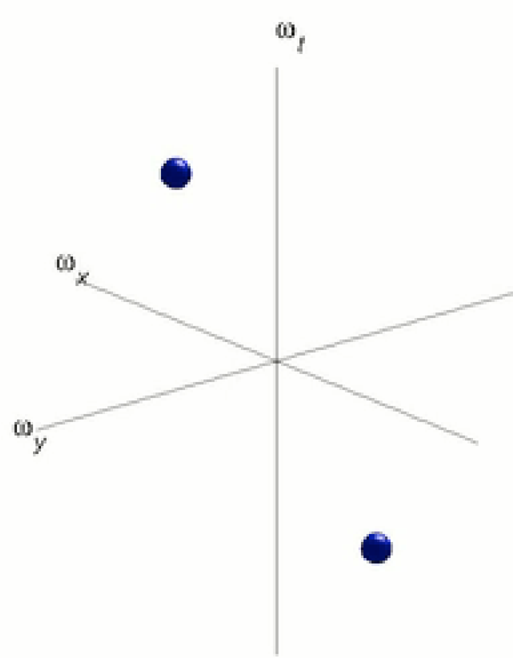
XYT





[video's c/o Tim Saint]





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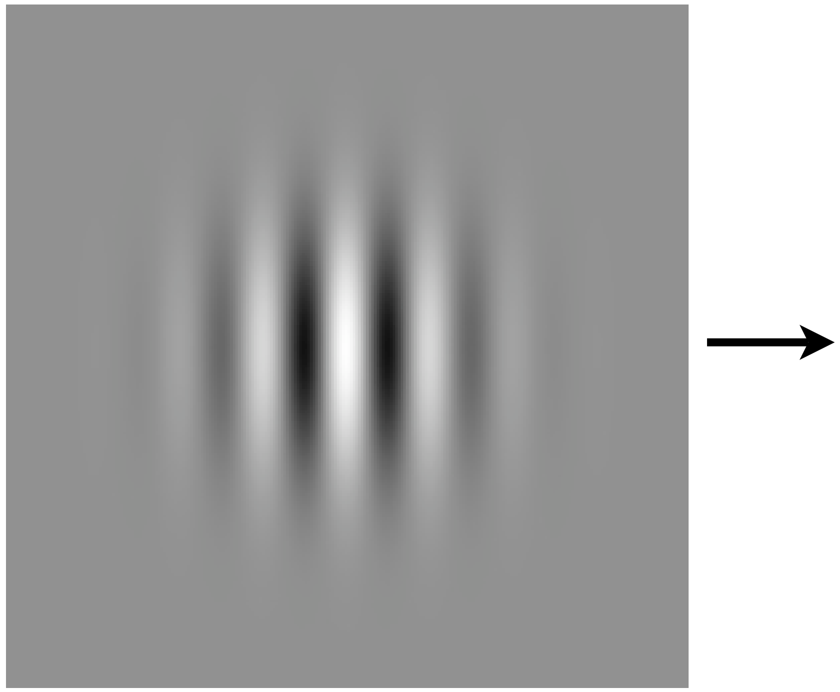

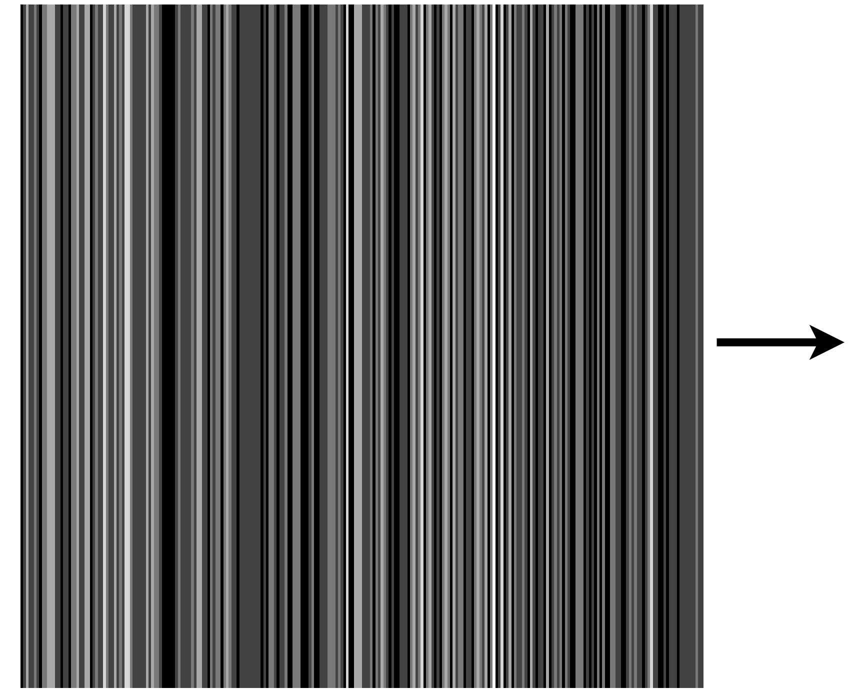

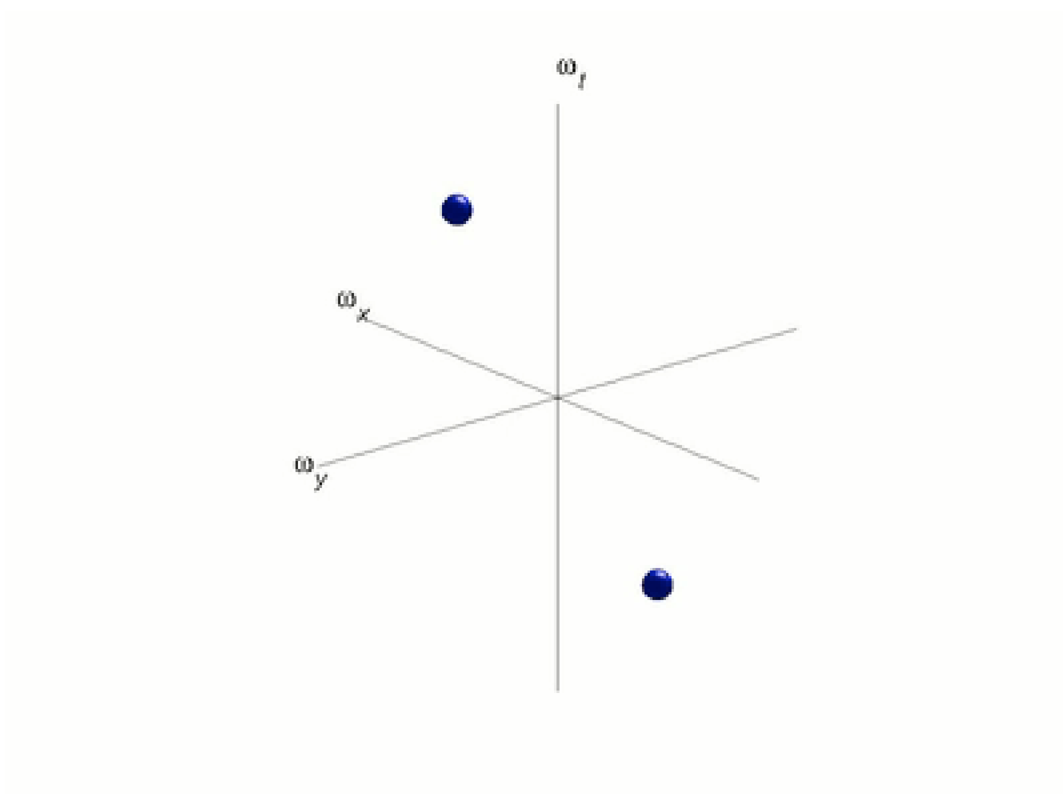

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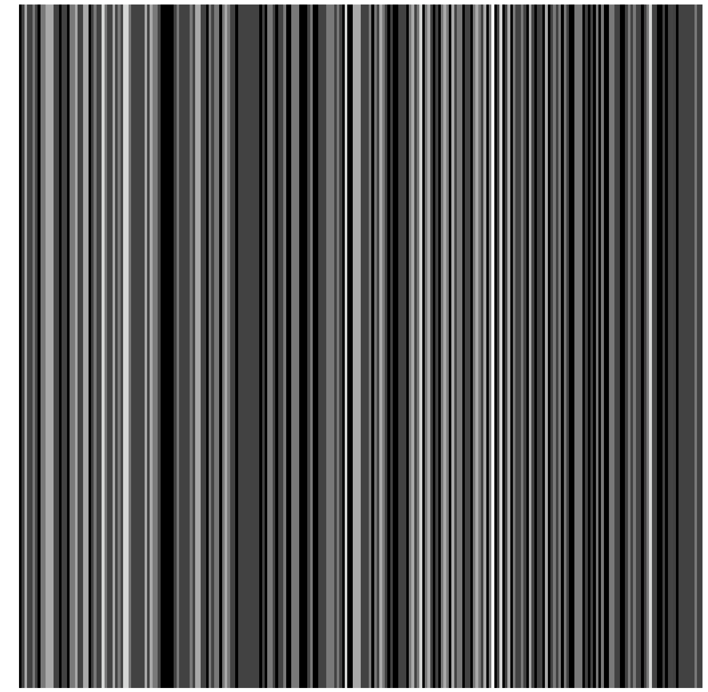

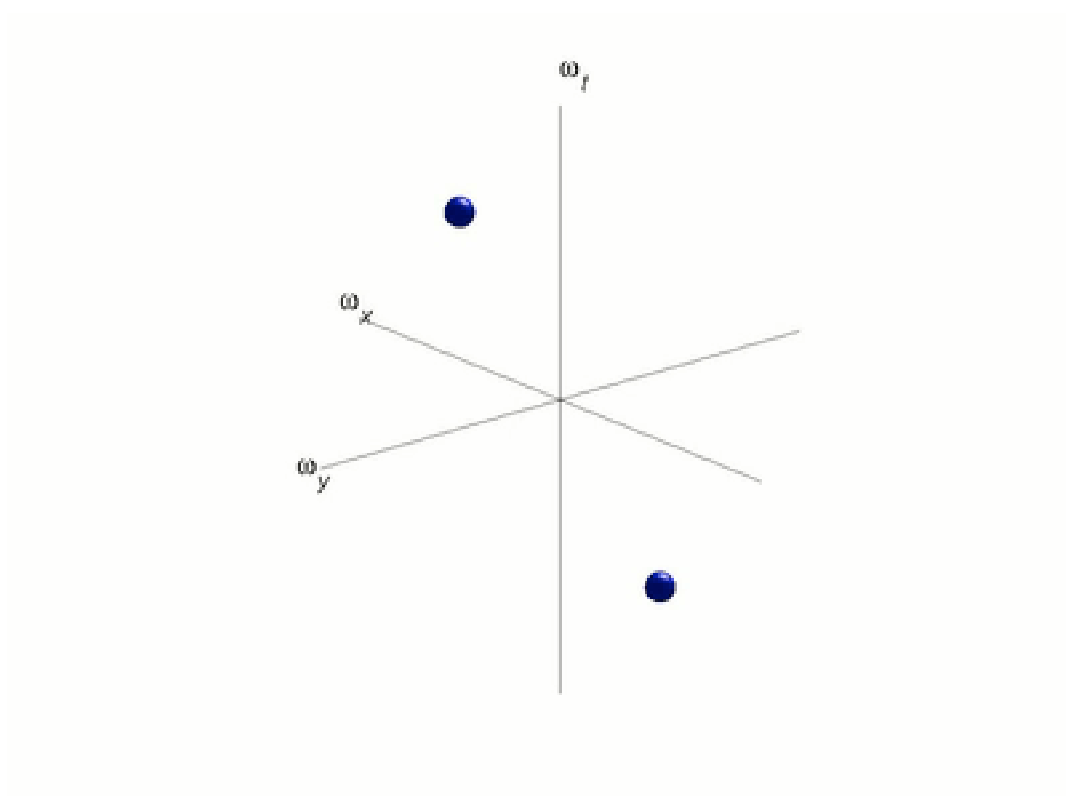

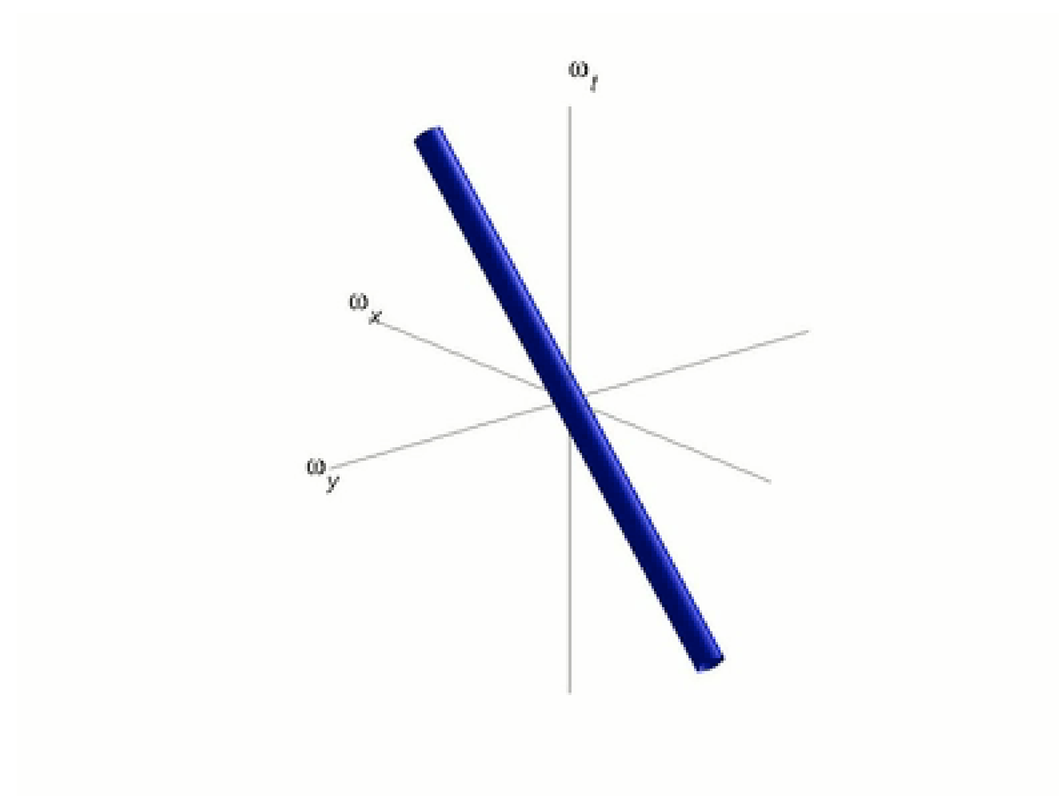

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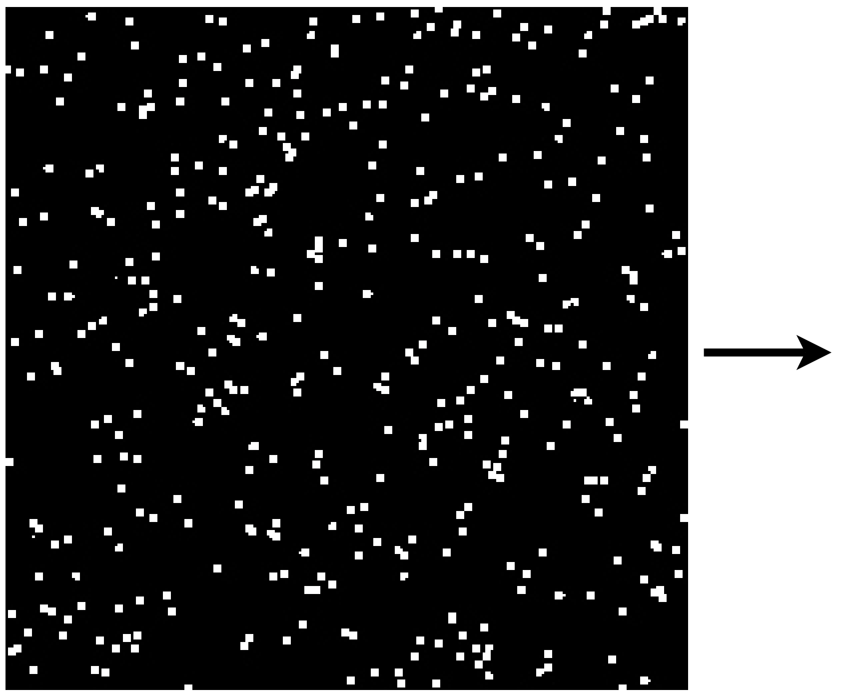
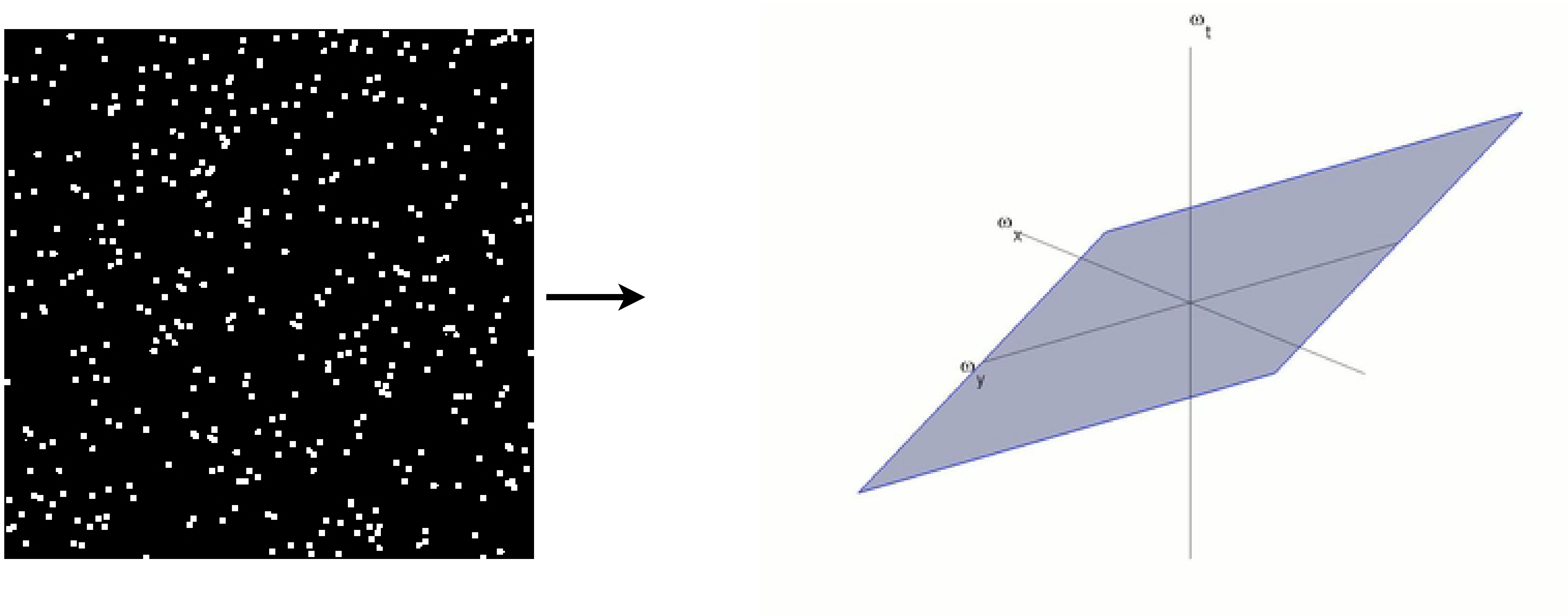


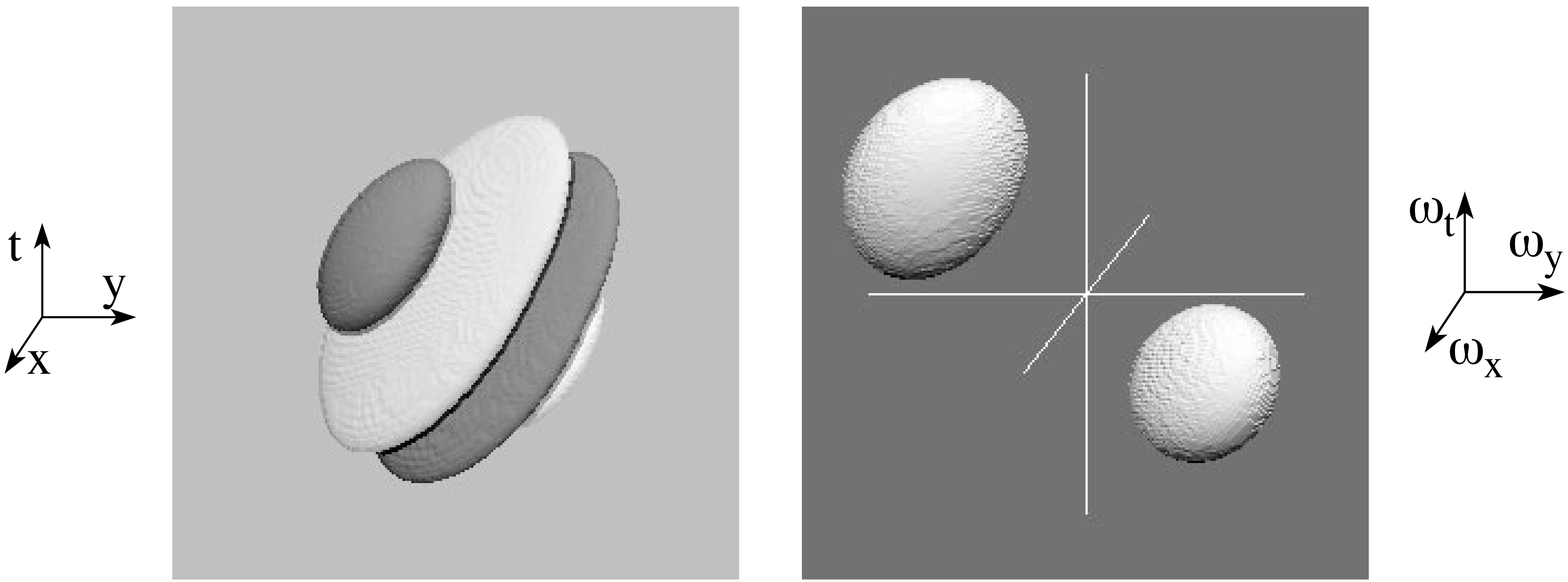
Watson & Ahumada, 1985



Spectral power of translating power lies on a plane in the Fourier domain

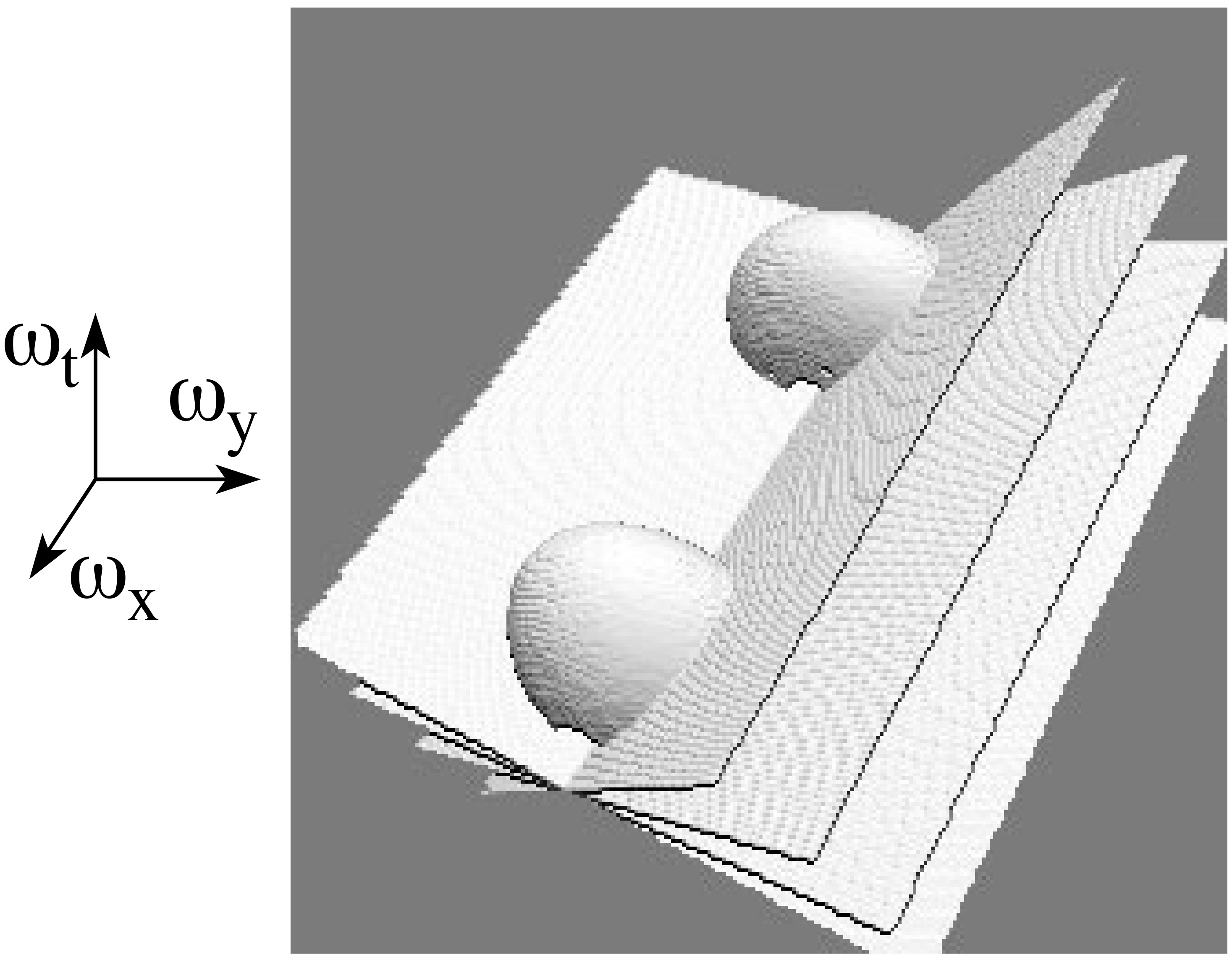
Watson & Ahumada, 1985

Direction-selective filter



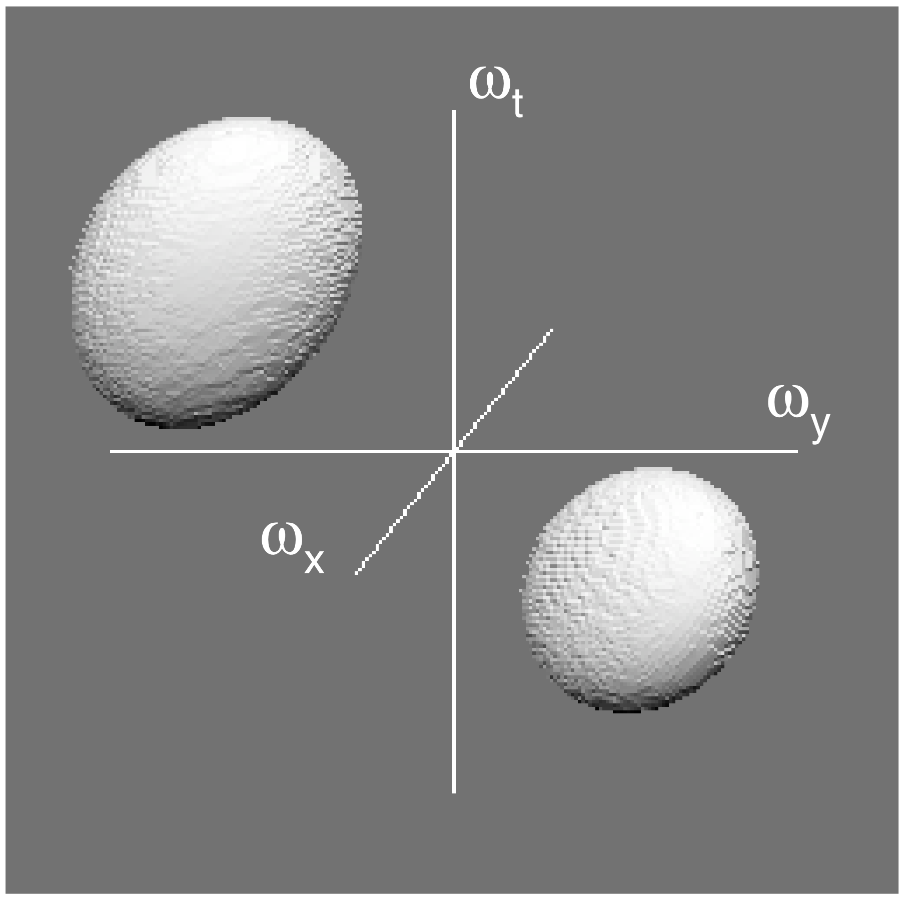
Loosely speaking, V1 cells represent balls of spectral energy

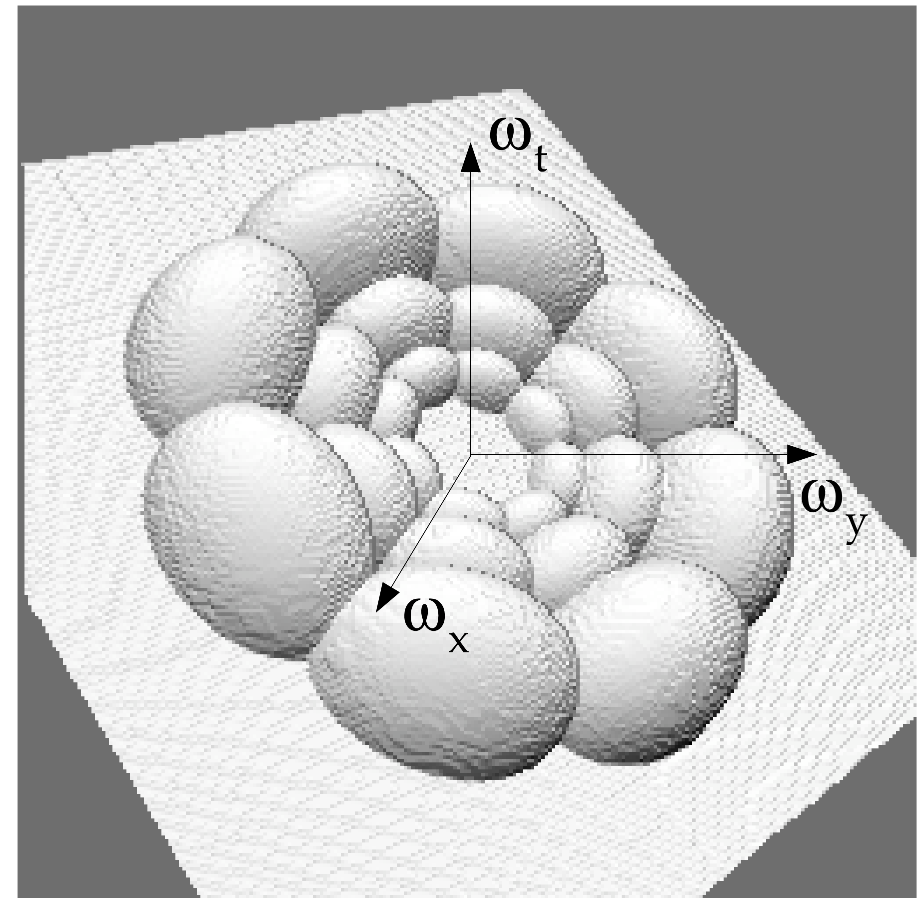
Filter is not velocity-selective



Simoncelli, 1993

Linear velocity selectivity



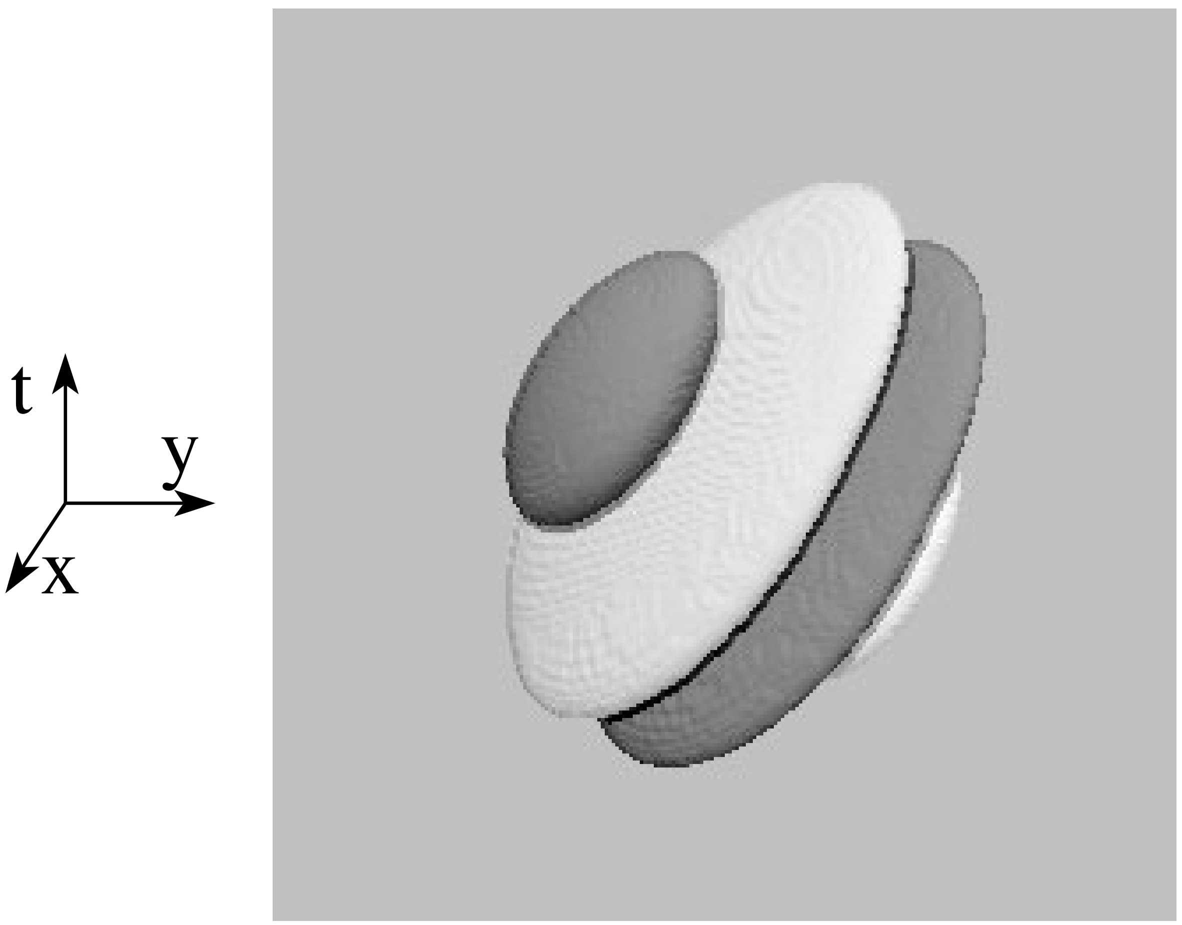


Add spectral energy on plane
Subtract spectral energy off plane

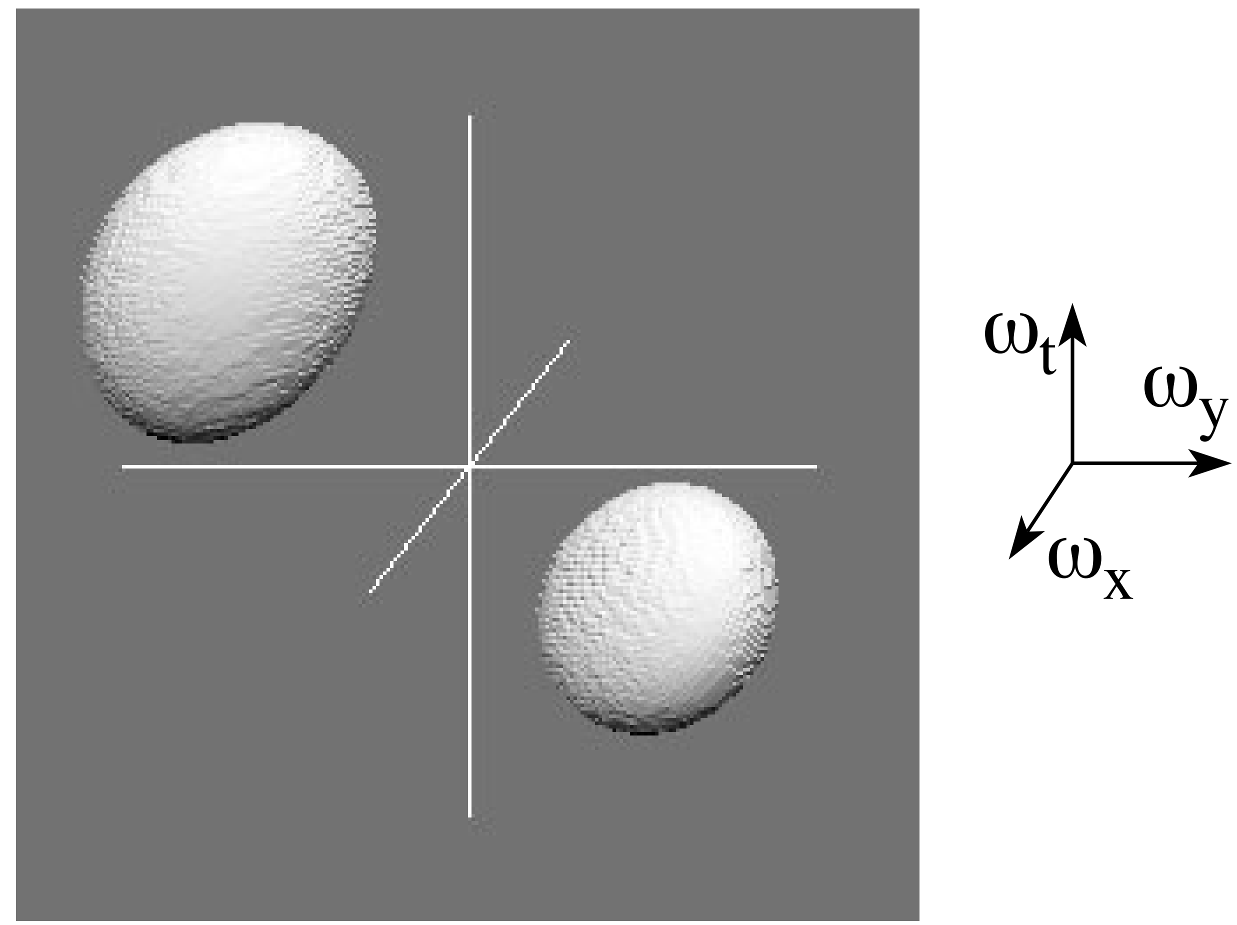
Simoncelli, 1993

V1

Linear weighting



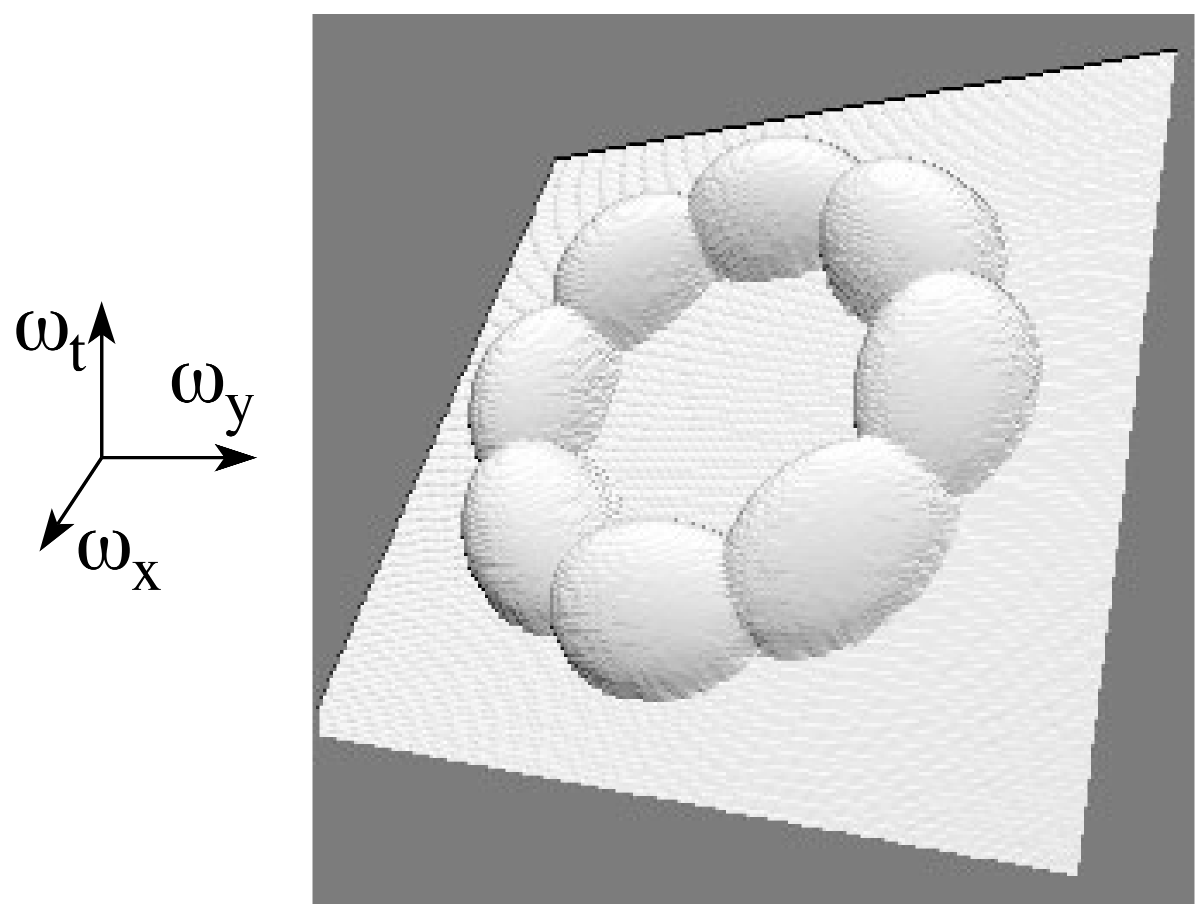
Tuning



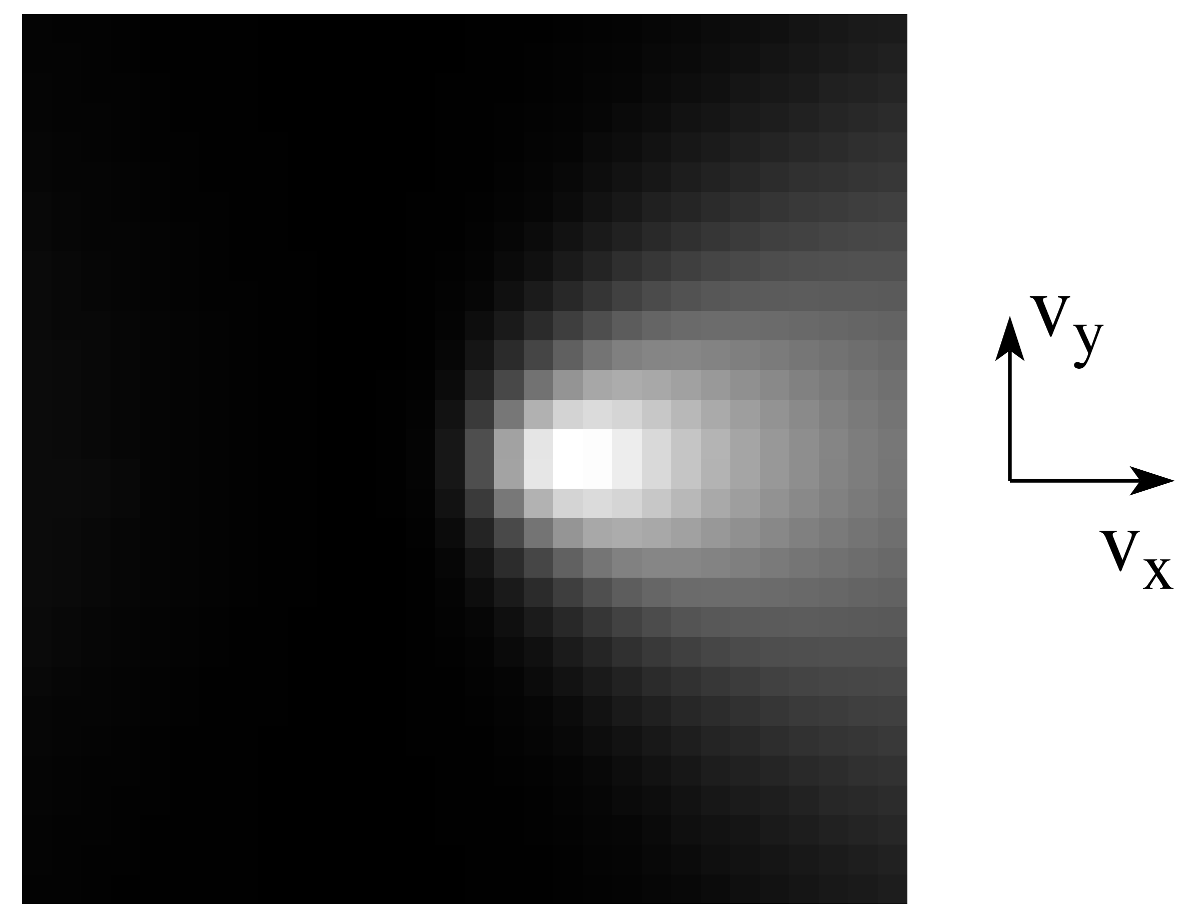
Simoncelli, 1993

MT

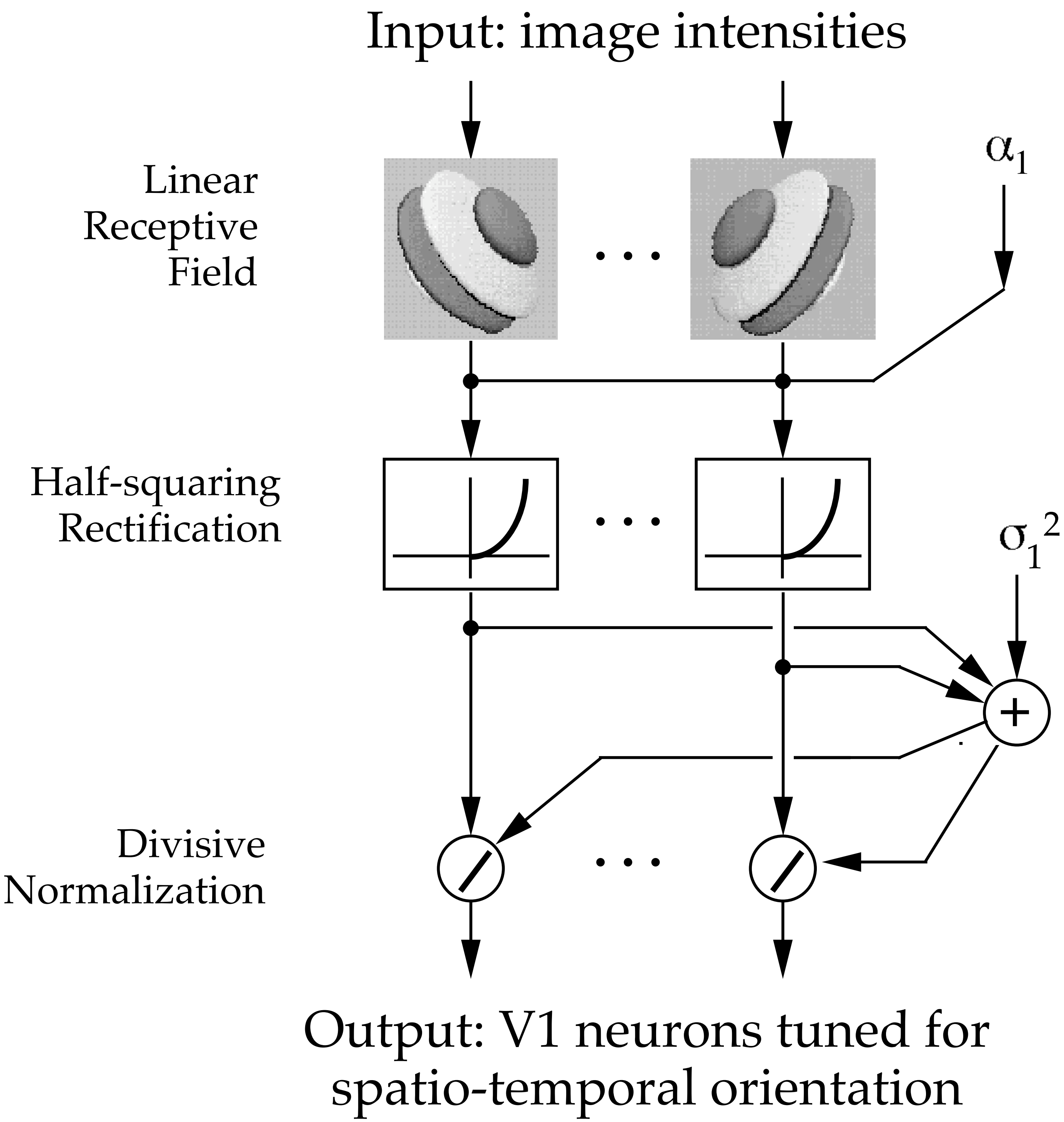
Linear weighting



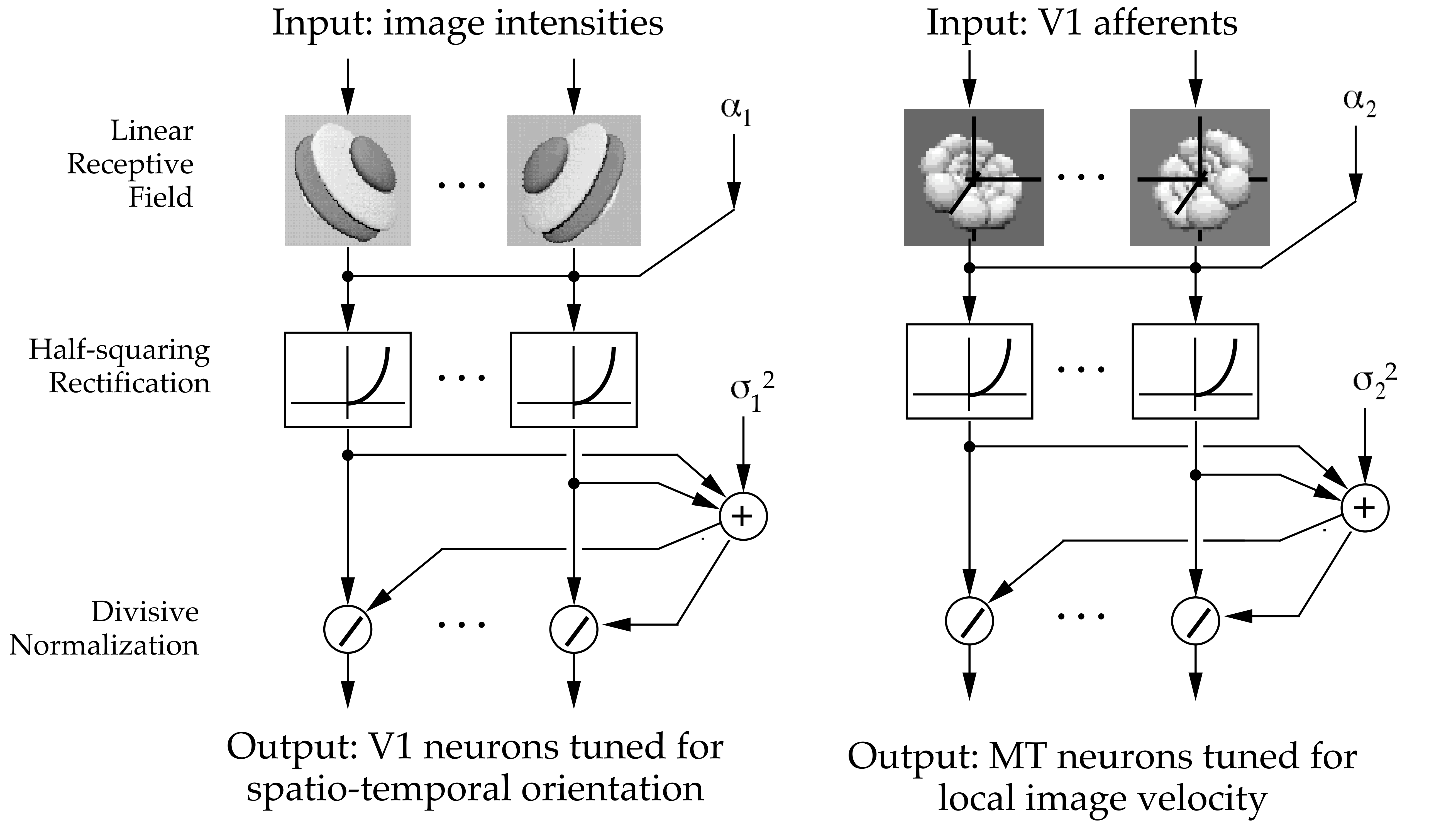
Tuning



Simoncelli, 1993

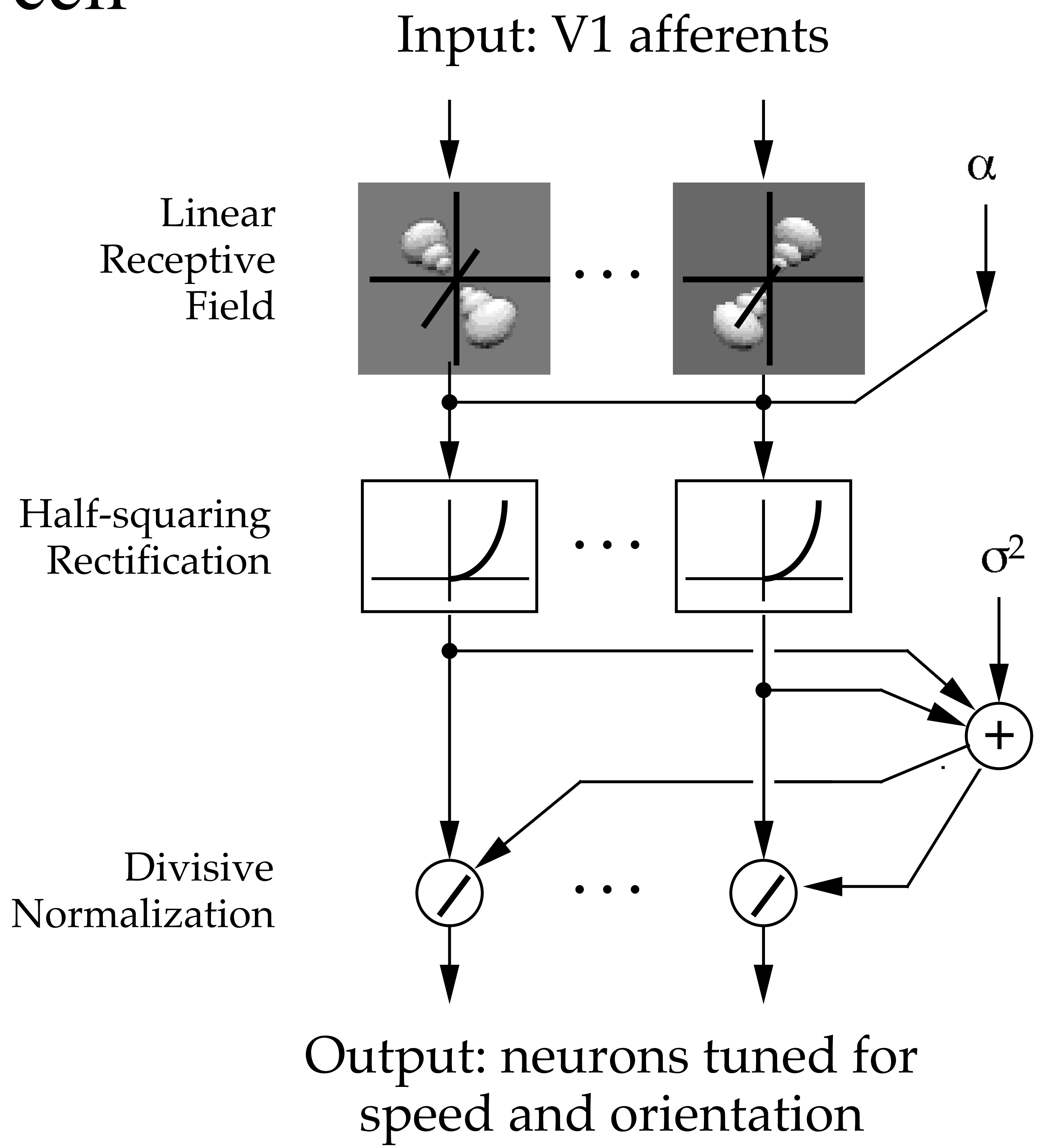


Simoncelli and Heeger, 1998

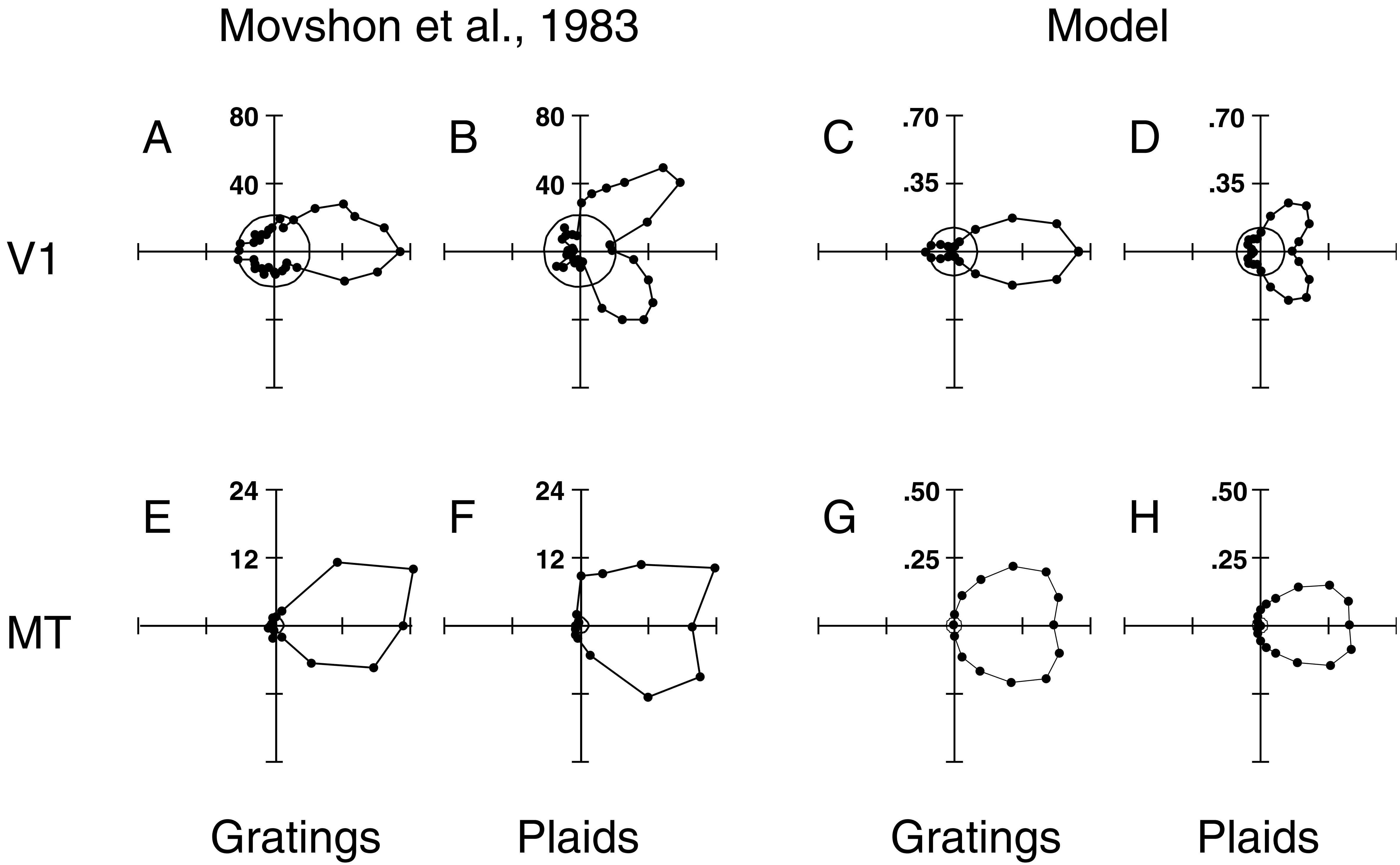


Simoncelli and Heeger, 1998

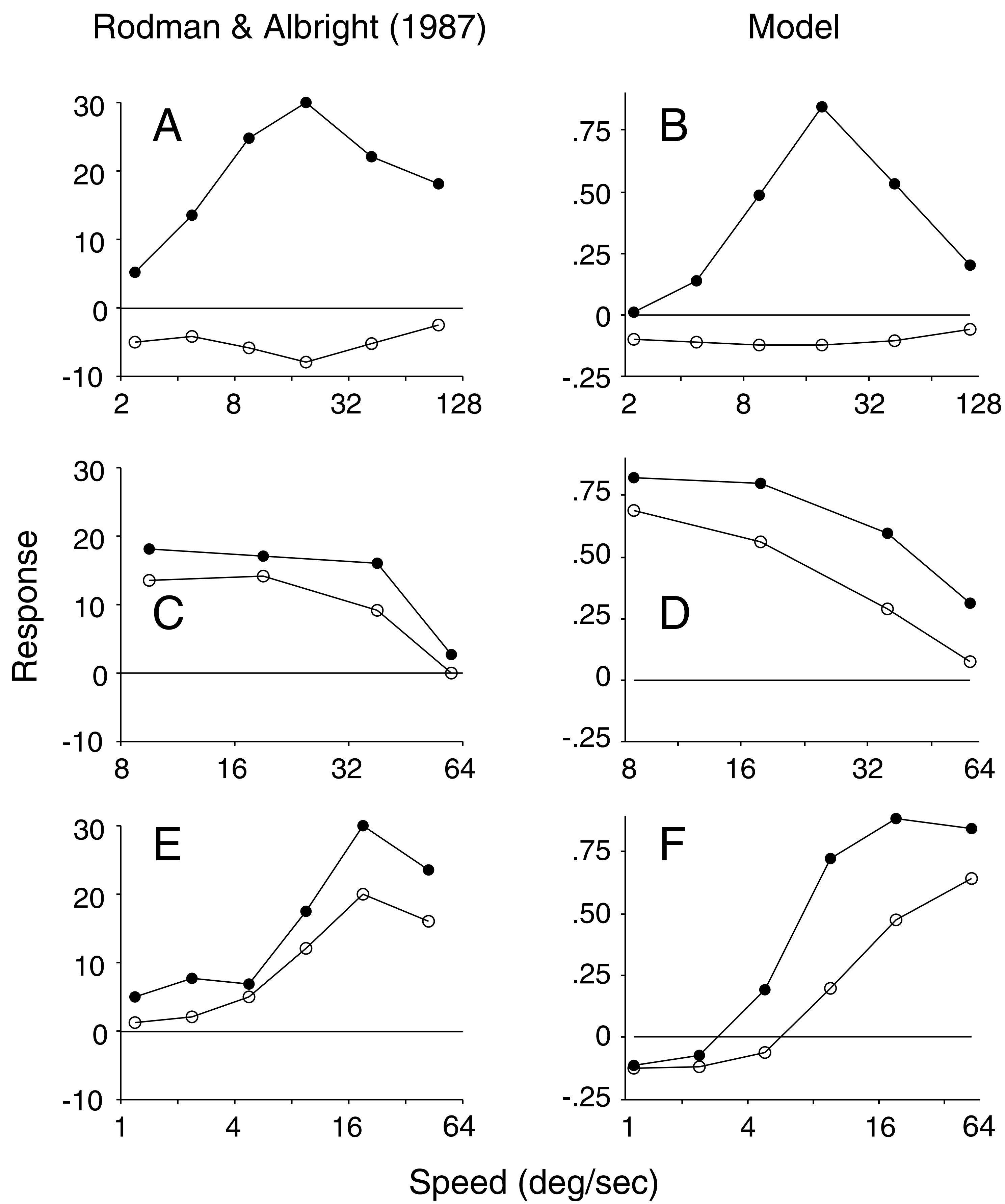
Component cell

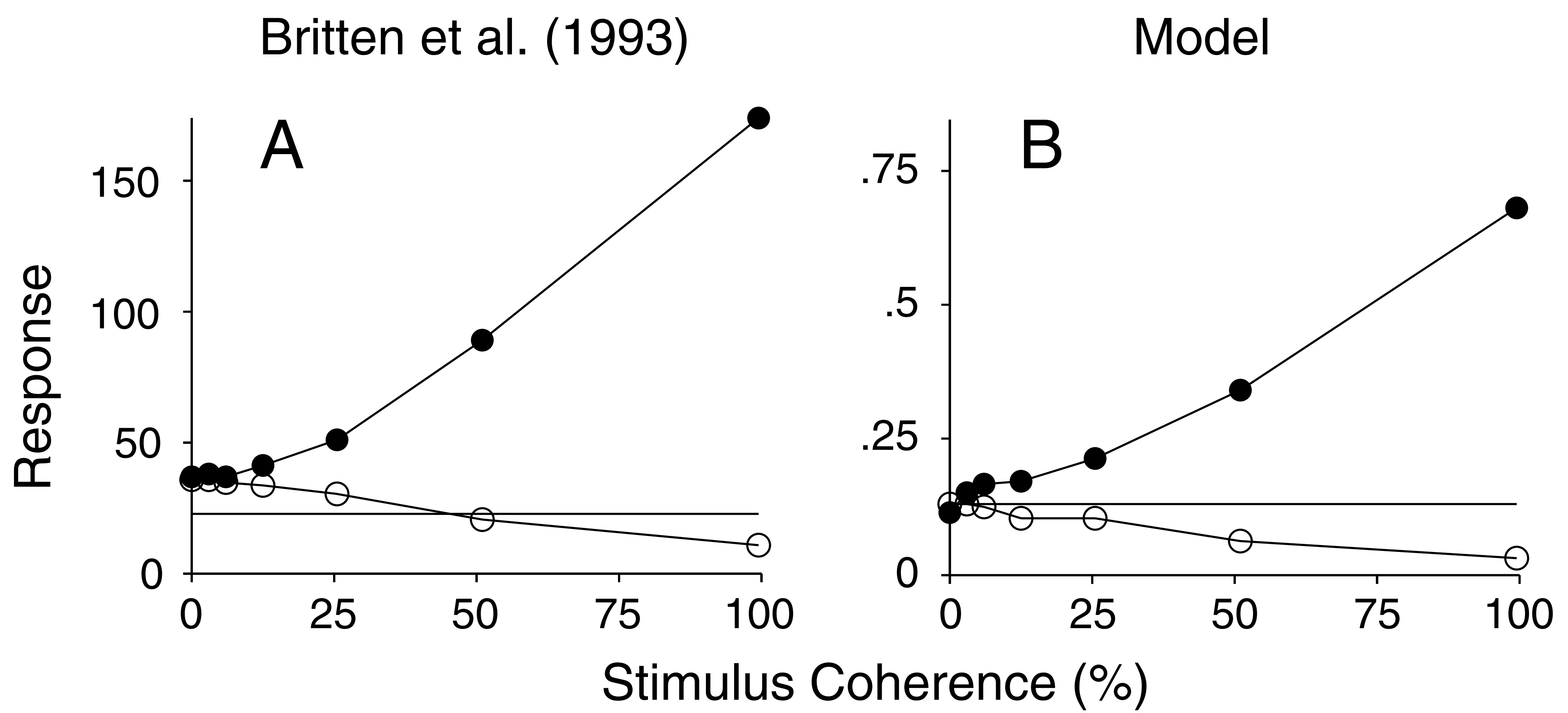


Simoncelli and Heeger, 1998



Simoncelli and Heeger, 1998


Rodman & Albright (1987)
Model
A
B
C
D
E
F
Response
Speed (deg/sec)
30
20
10
0
-10
.75
.50
.25
-.25
2
8
32
128
16
64
1
4

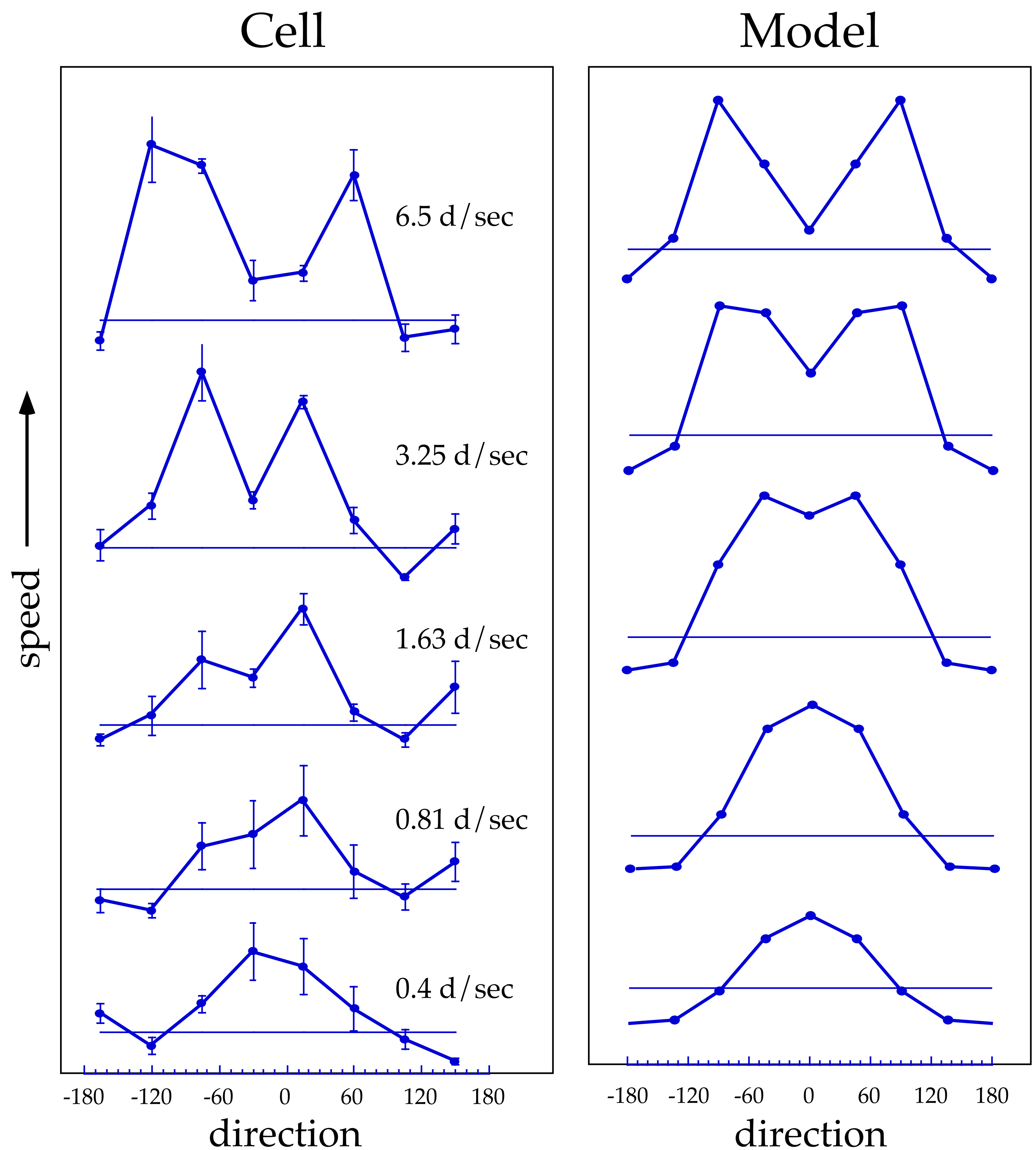


Britten et al. (1993)
Model
A
B
Response
150
100
50
0
.75
.5
.25
0
0
25
50
75
100
Stimulus Coherence (%)

Direction-tuning predictions

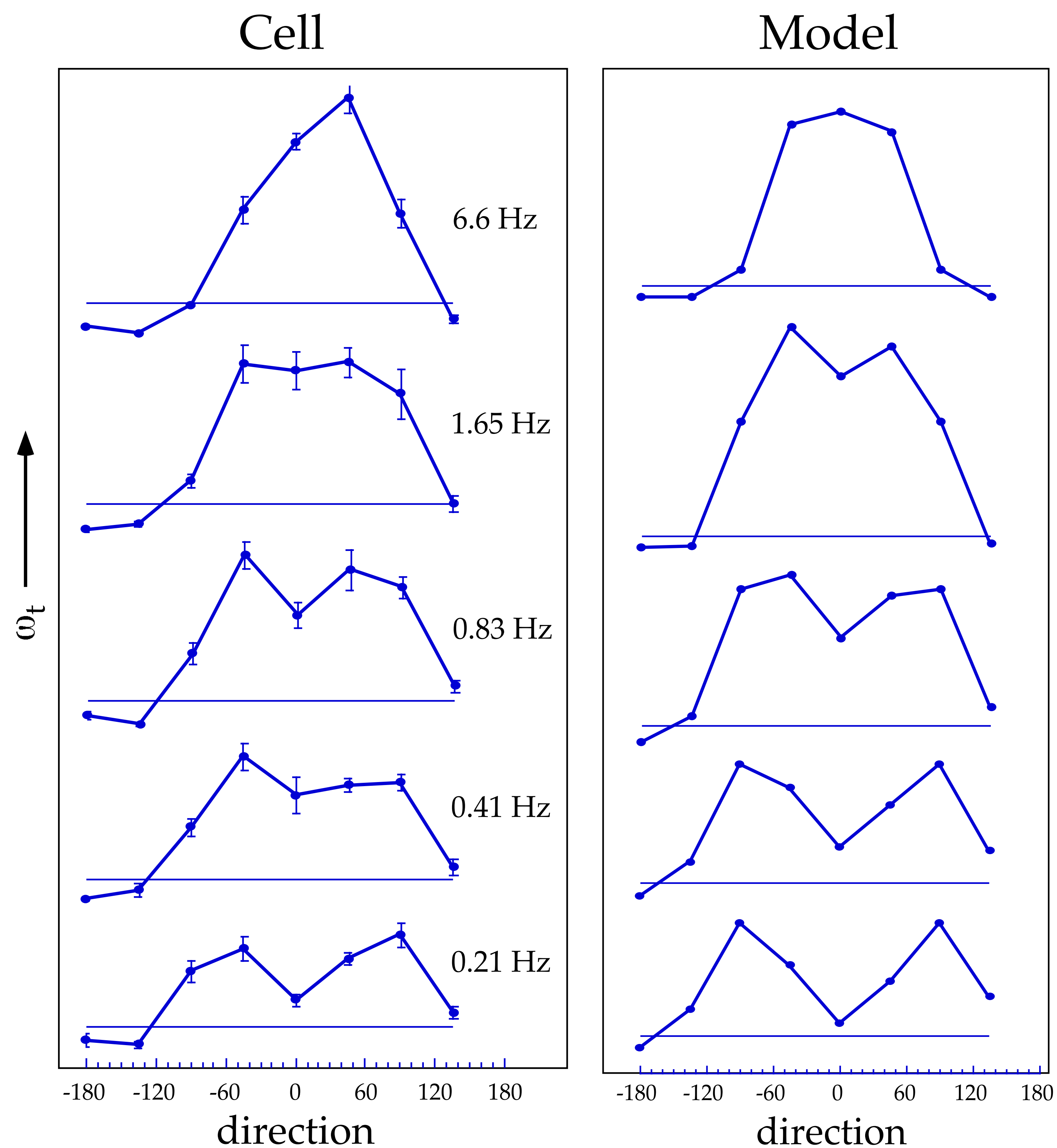
stimulus \ cell type	component	pattern
grating	unimodal	bimodal at low speeds
dots	bimodal at high speeds	unimodal

Component Cell / Drifting Dots



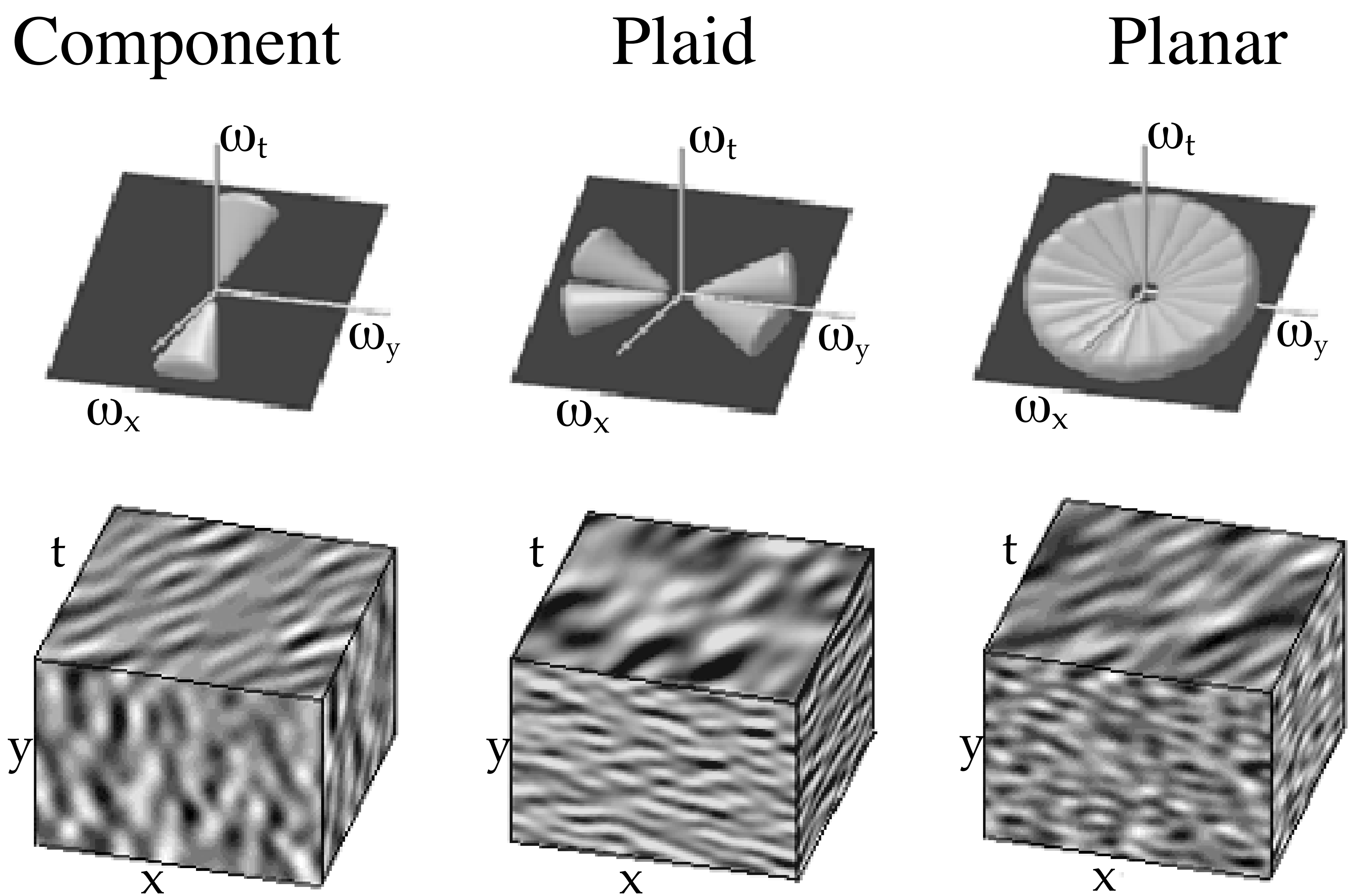
Simoncelli, Bair, Cavanaugh, Movshon, ARVO-96

Pattern Cell / Sine Grating



Simoncelli, Bair, Cavanaugh, Movshon, ARVO-96

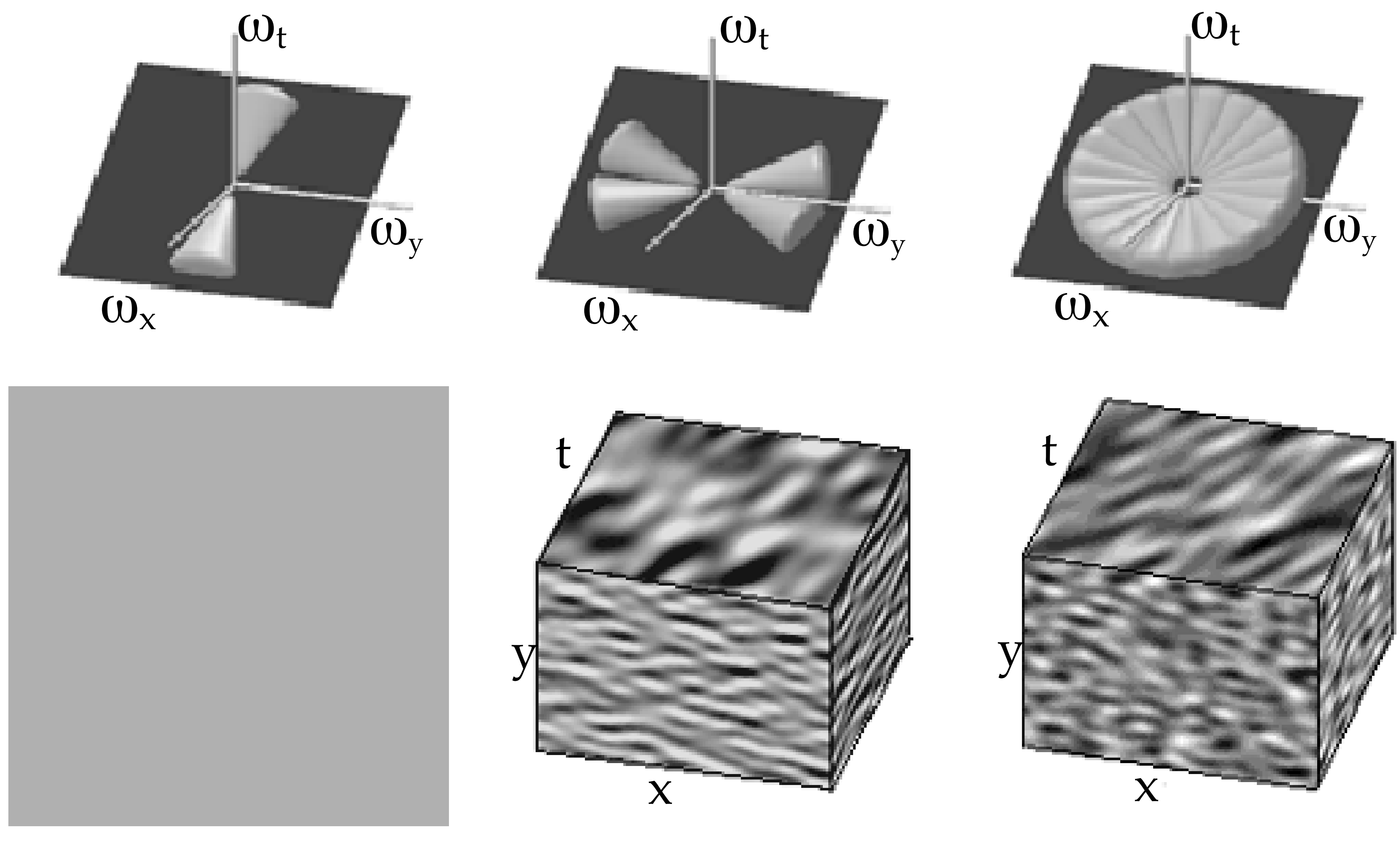
Stochastic spectral stimuli



Schrater, Knill, and Simoncelli, 2000

Stochastic spectral stimuli

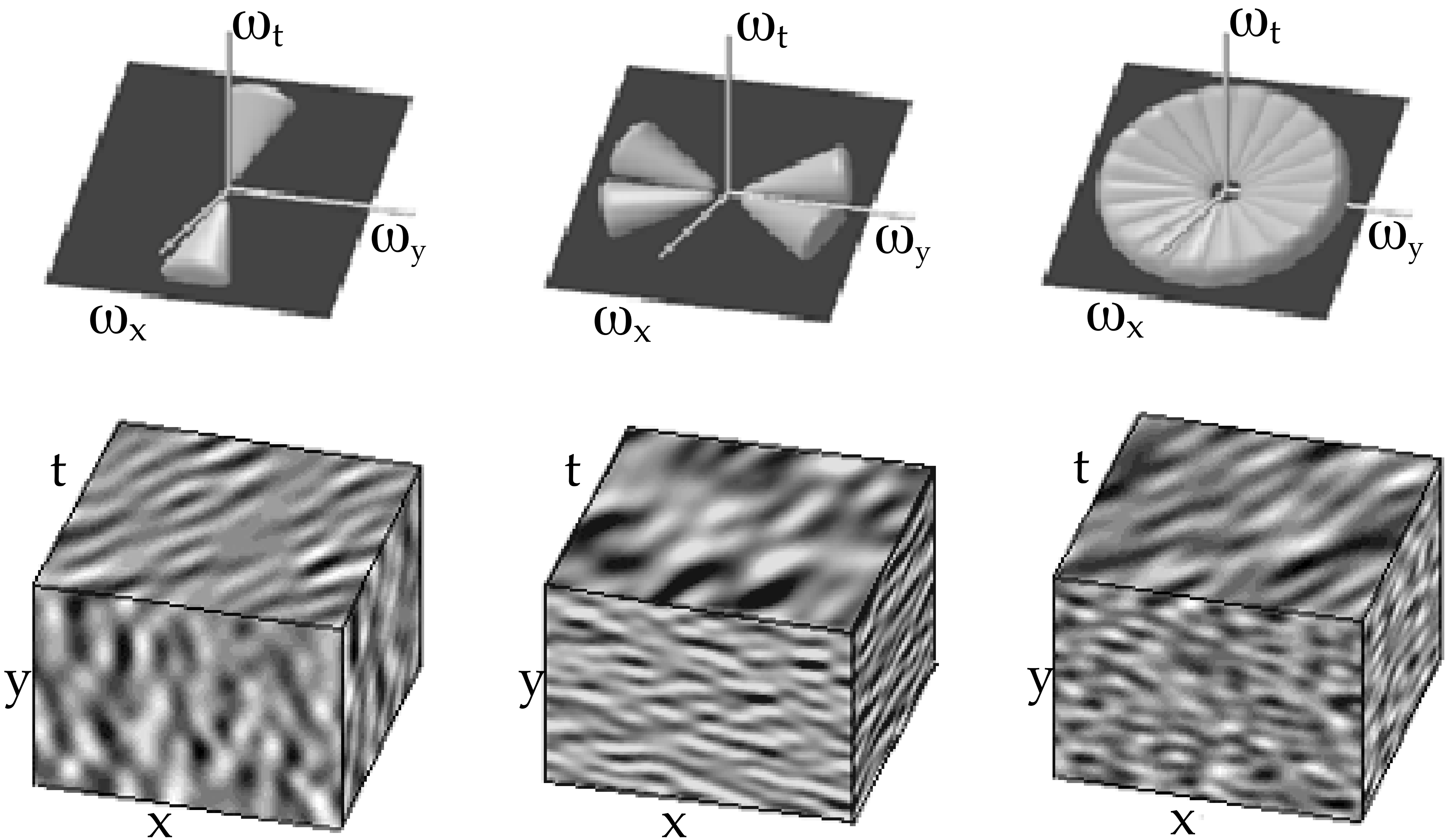
Component | Plaid | Planar



Schrater, Knill, and Simoncelli, 2000

Stochastic spectral stimuli

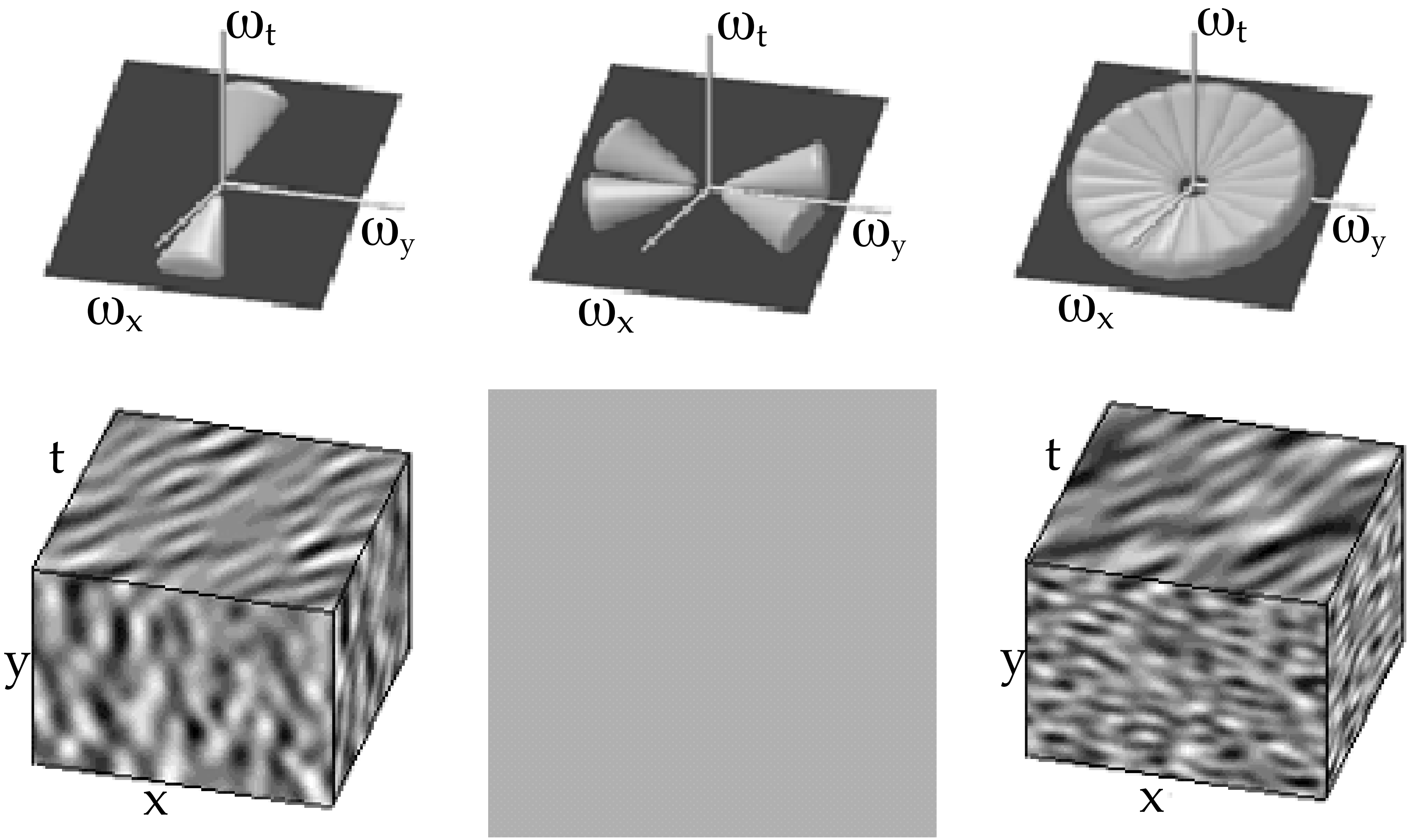
Component Plaid Planar



Schrater, Knill, and Simoncelli, 2000

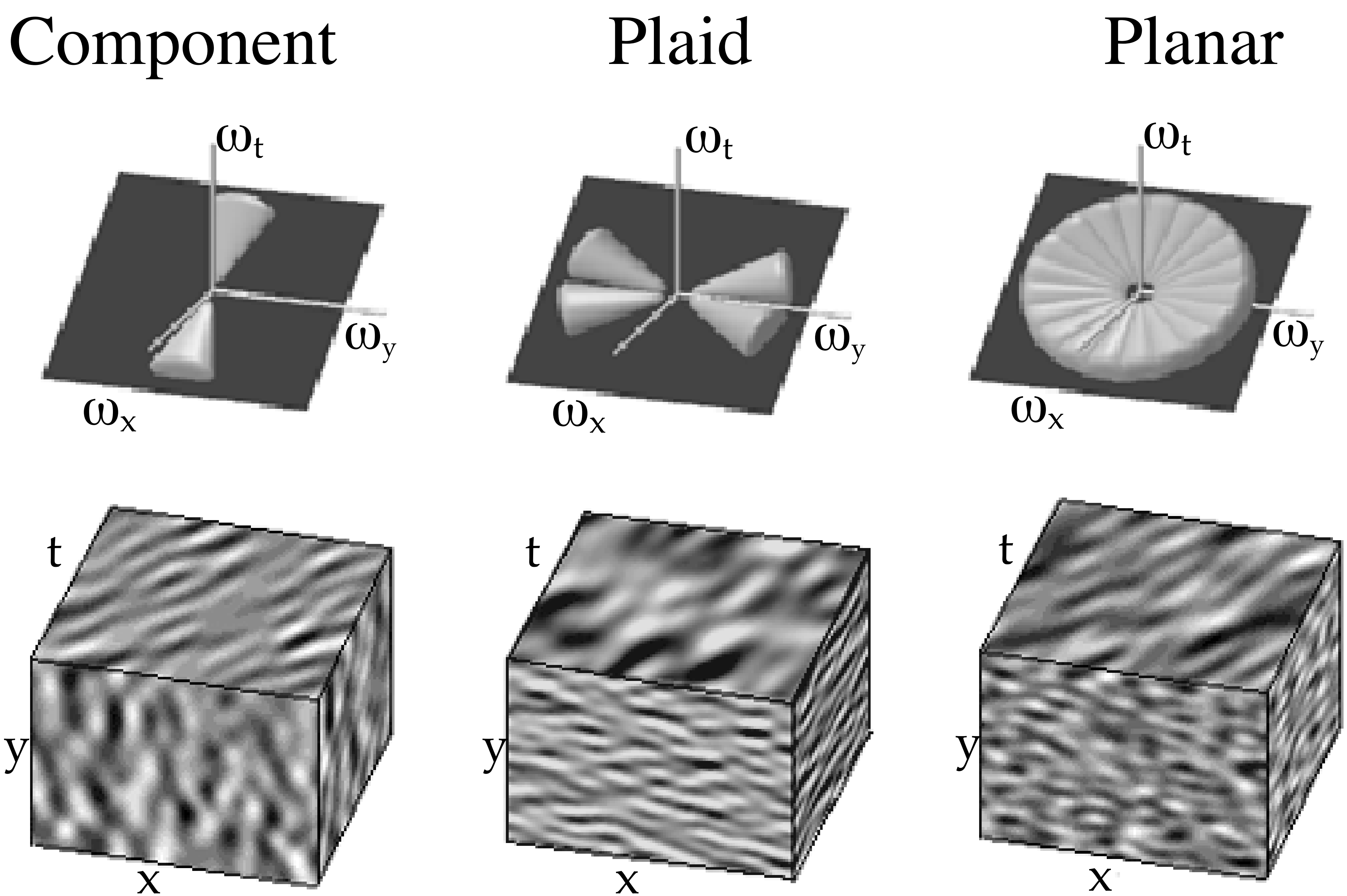
Stochastic spectral stimuli

Component | Plaid | Planar



Schrater, Knill, and Simoncelli, 2000

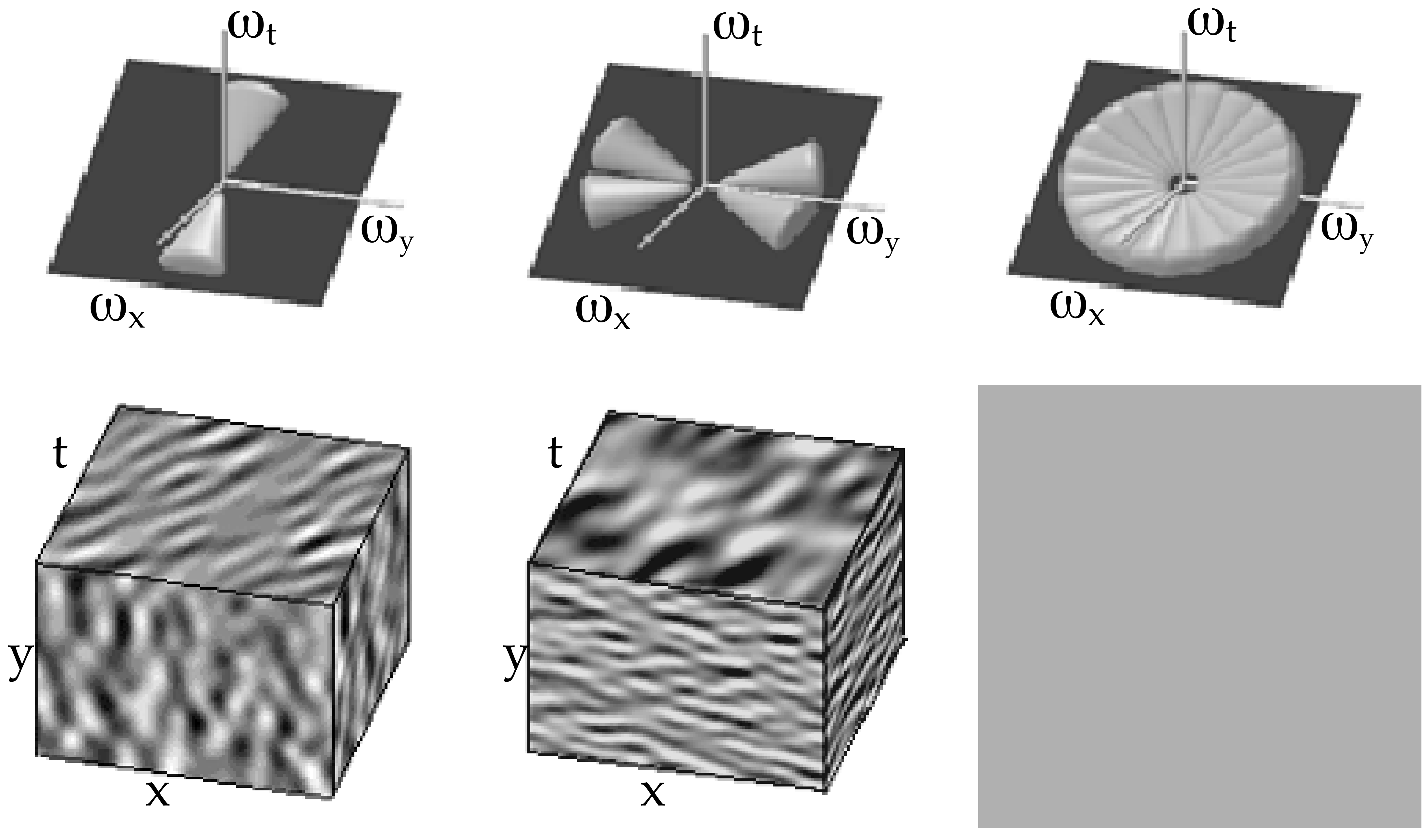
Stochastic spectral stimuli



Schrater, Knill, and Simoncelli, 2000

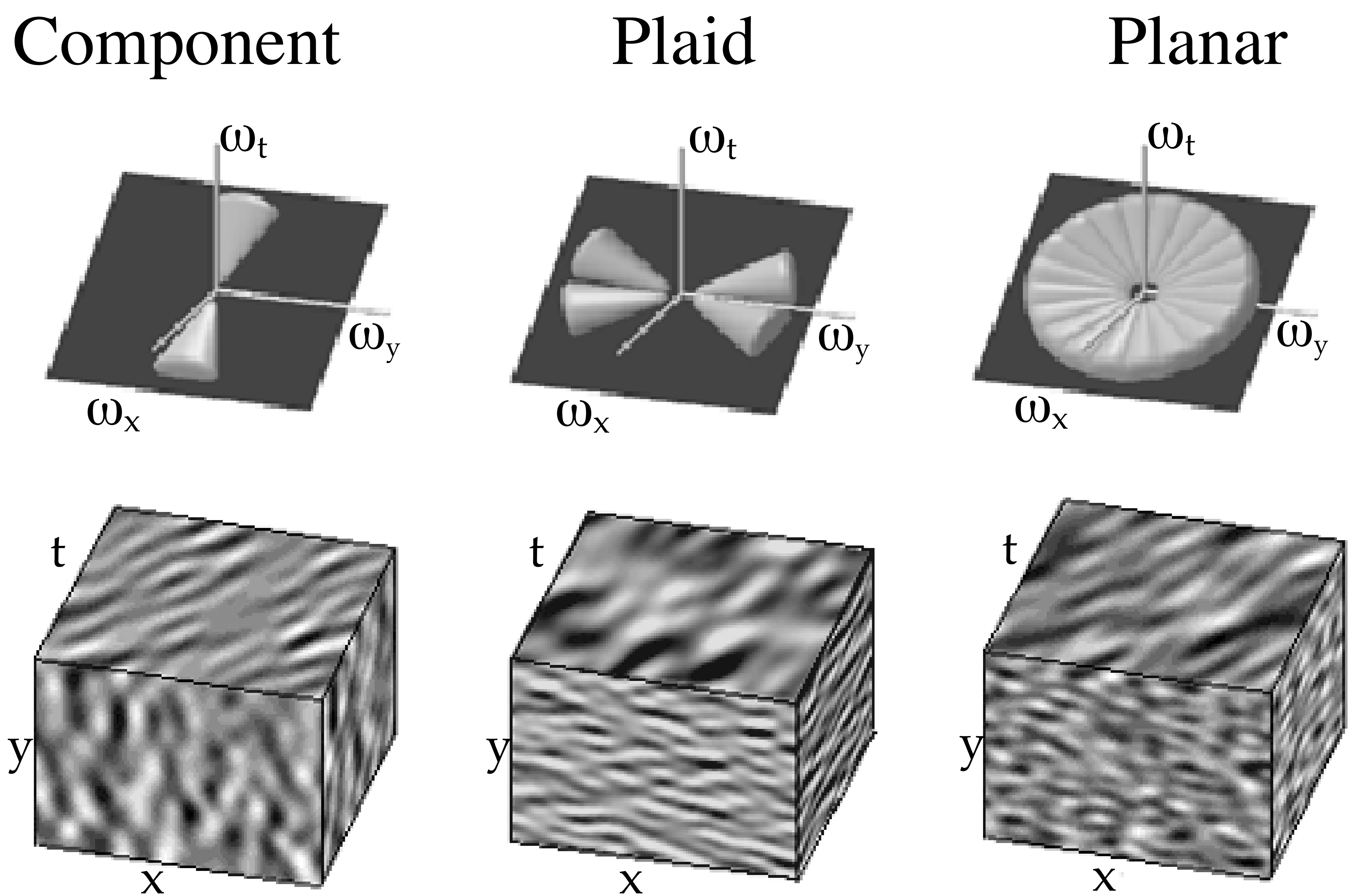
Stochastic spectral stimuli

Component | Plaid | Planar



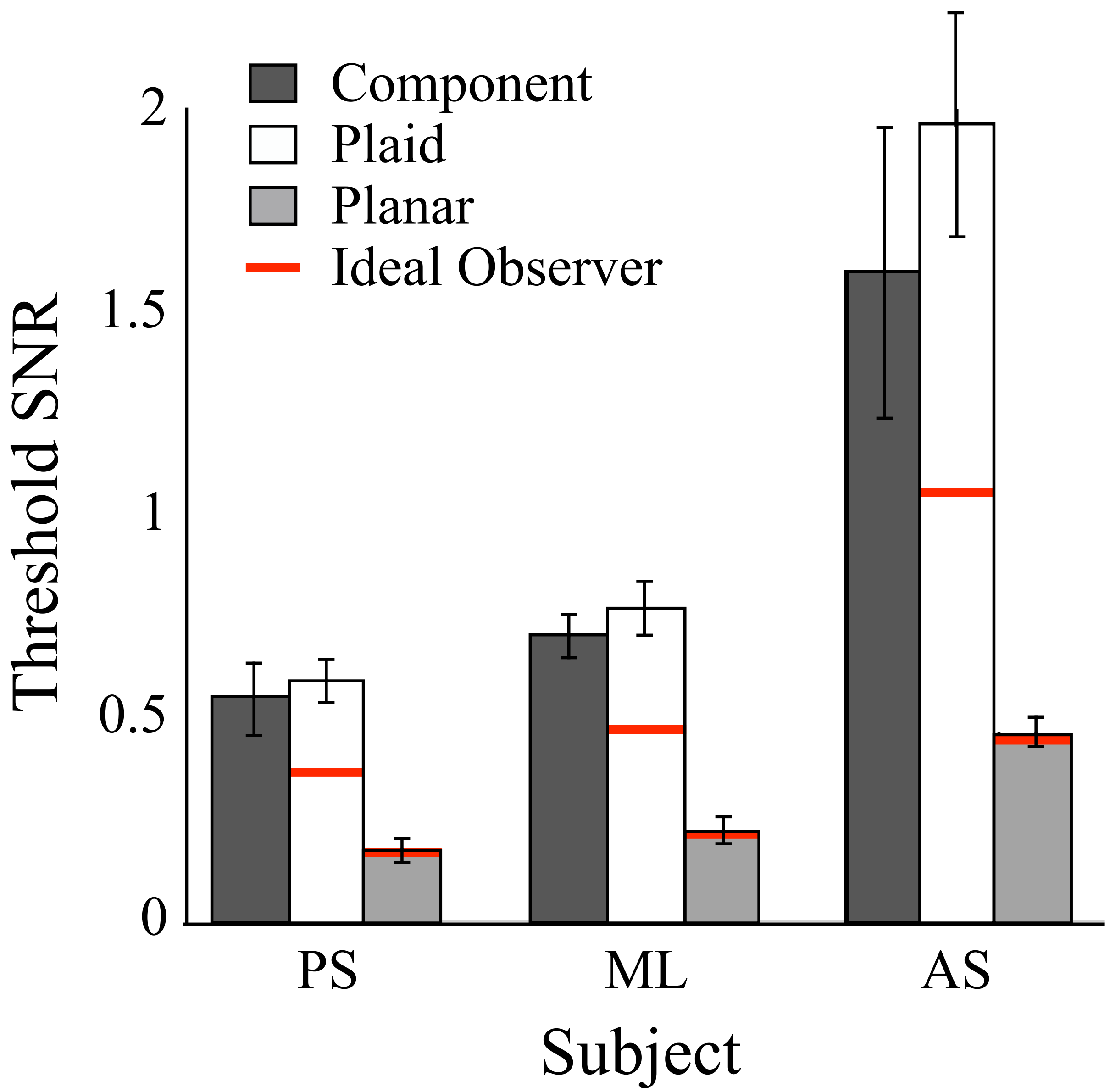
Schrater, Knill, and Simoncelli, 2000

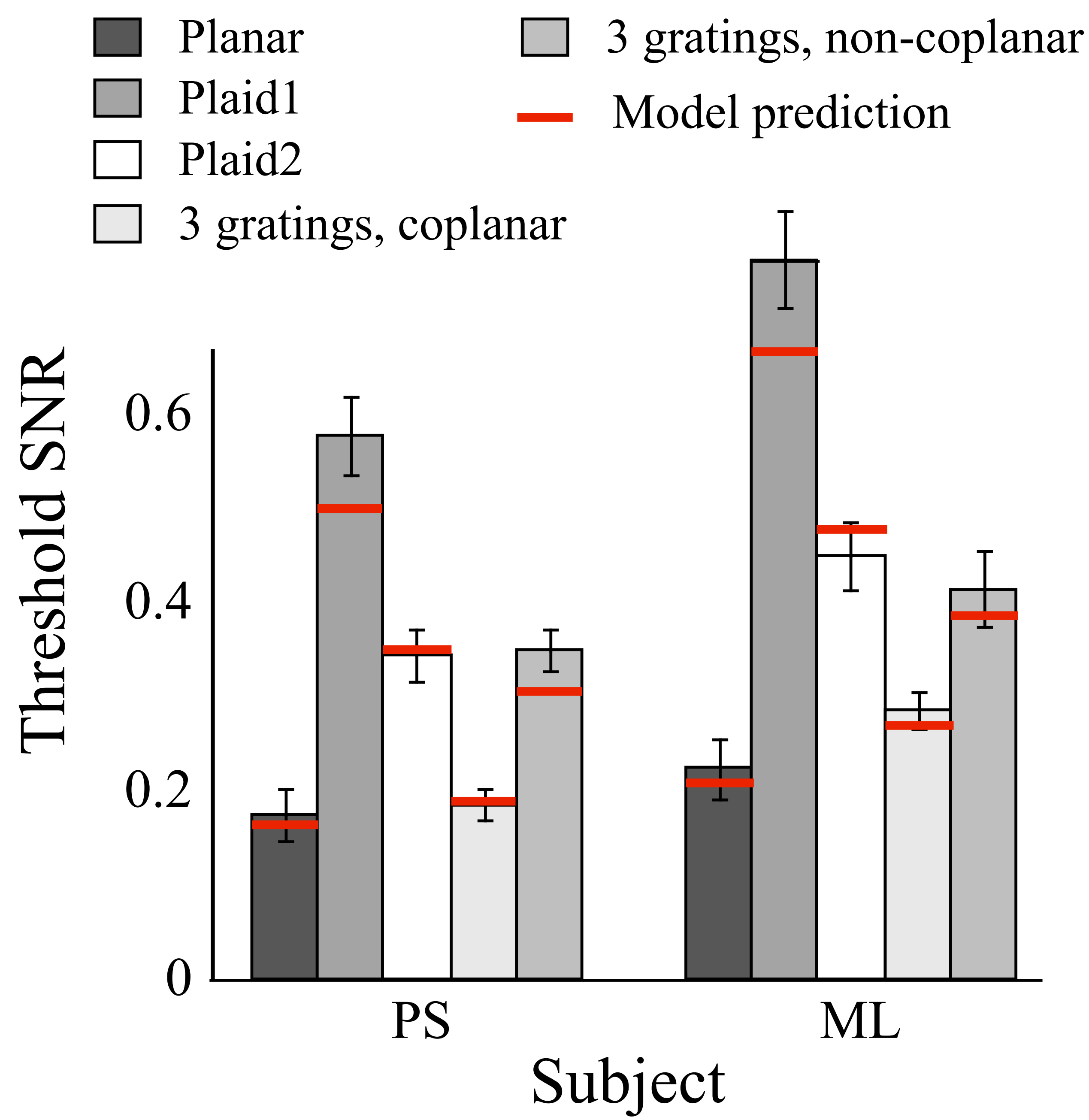
Stochastic spectral stimuli



Schrater, Knill, and Simoncelli, 2000

Detection thresholds





Schrater, Knill, and Simoncelli, 2000