

Given an unknown, moving scene and an unknown occluder, can we recover both the occluder and the scene?

Moving scene



Static occluder

Observation

(= scene * occluder)

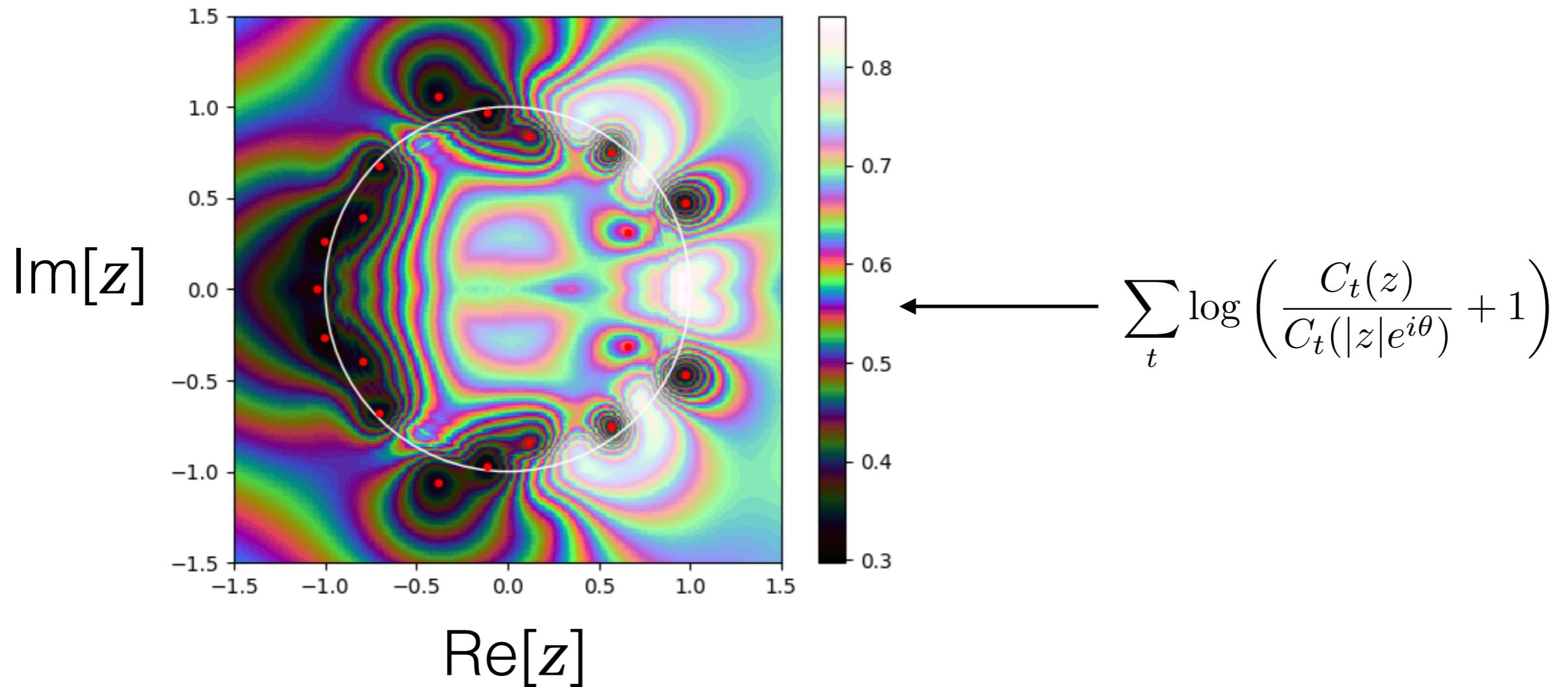
Idea: given that the movie changes and the occluder stays still, we can use the z-transform to disambiguate between the two.

Ground truth scene movie	Occluder	Observation movie
$t \downarrow$ $\begin{bmatrix} \vec{a}_1 \\ \vec{a}_2 \\ \vec{a}_3 \\ \dots \\ \vec{a}_T \end{bmatrix}$	$*$	$=$ $\begin{bmatrix} b \\ b \\ b \\ \dots \\ b \end{bmatrix}$

If we let $A_t(z)$, $B(z)$, $C_t(z)$ be the z-transforms of a_t , b , c_t ,
 then $C_t(z) = A_t(z)B(z)$
 and $\text{roots}(C_t(z)) = \text{roots}(A_t(z)) \cup \text{roots}(B(z))$.

So some of the roots of $C_t(z)$ will be the same every time,
 independent of t —those must be the roots of $B(z)$!

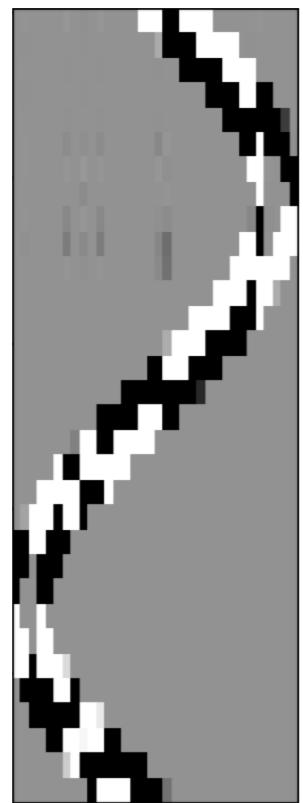
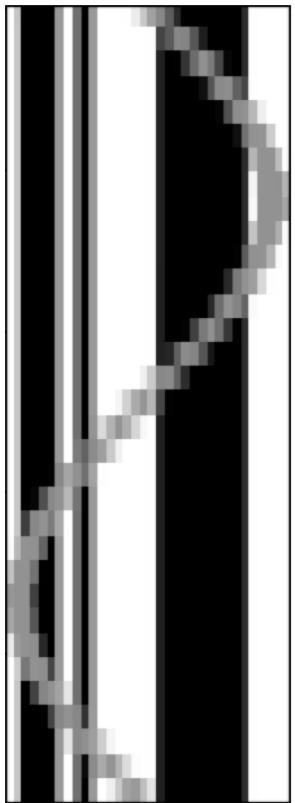
By aggregating over all the different $C_t(z)$, we can hope to reduce the effect of noise; we hope that the minima of the log-sum of the $C_t(z)$ will be the roots of $B(z)$.



The minima, marked by red dots, are presumed to be roots of $B(z)$. We can use these roots to recover b and with it the entire scene movie.

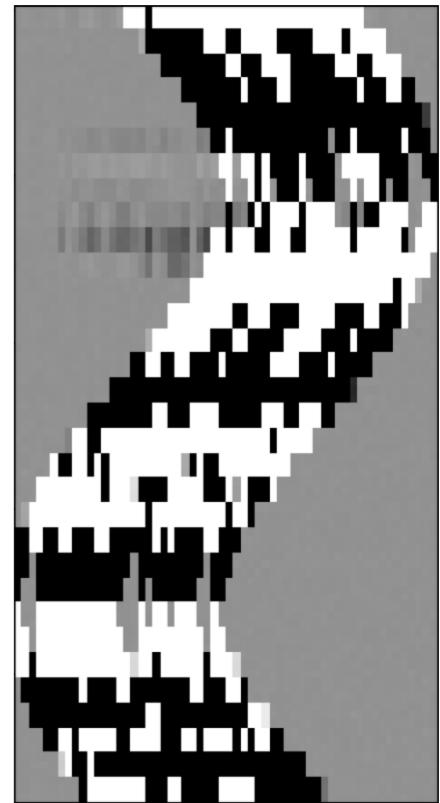
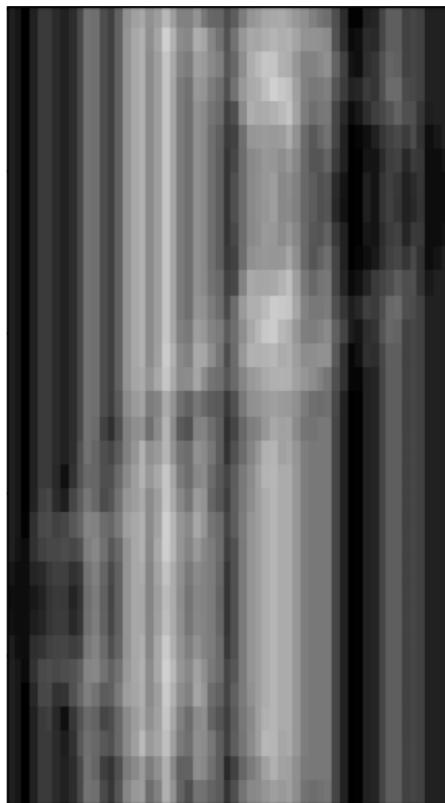
Ground truth
scene movie

$$\frac{d}{dt} \left(\text{Ground truth scene movie} \right)$$



Simulated
observation movie

$$\frac{d}{dt} \left(\text{Simulated observation movie} \right)$$



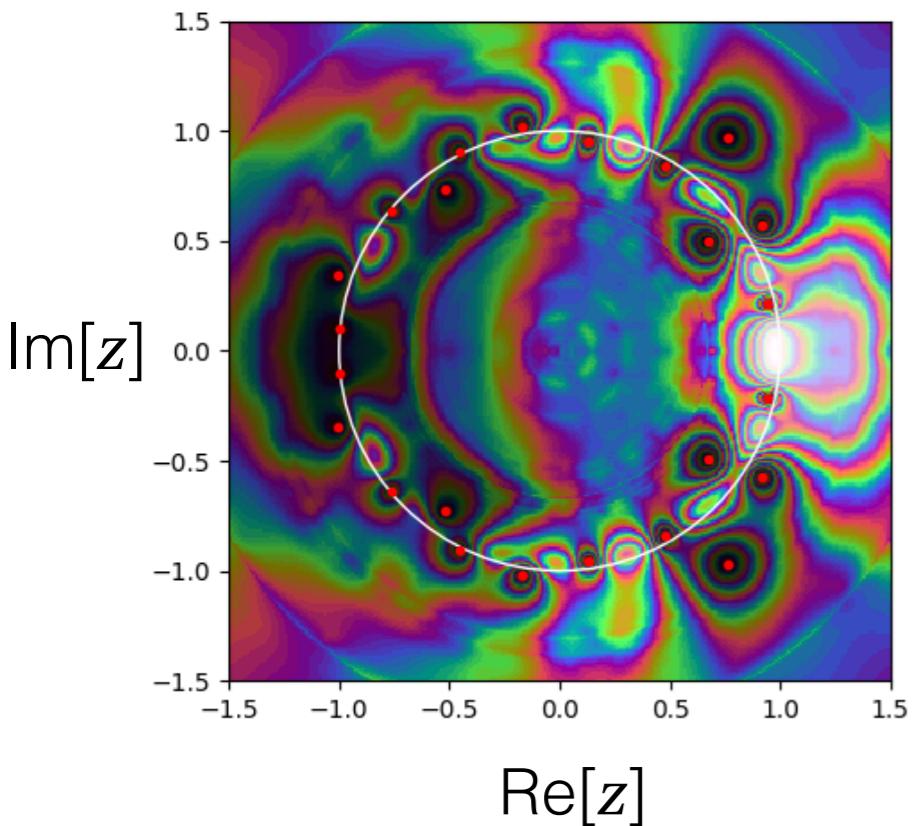
Ground truth occluder b

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Best local minima: assumed to be roots
of $B(z)$



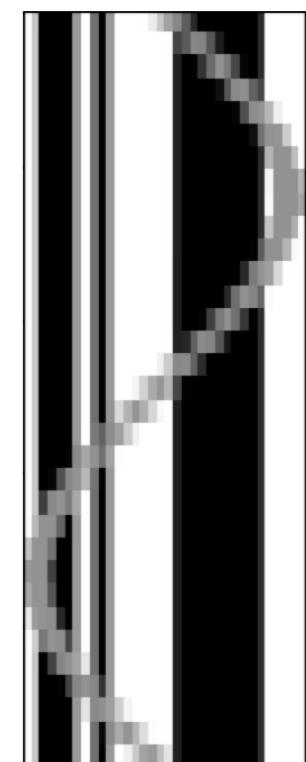
Construct
polynomial
from roots

Recovered occluder



Deconvolve

Recovered
scene movie

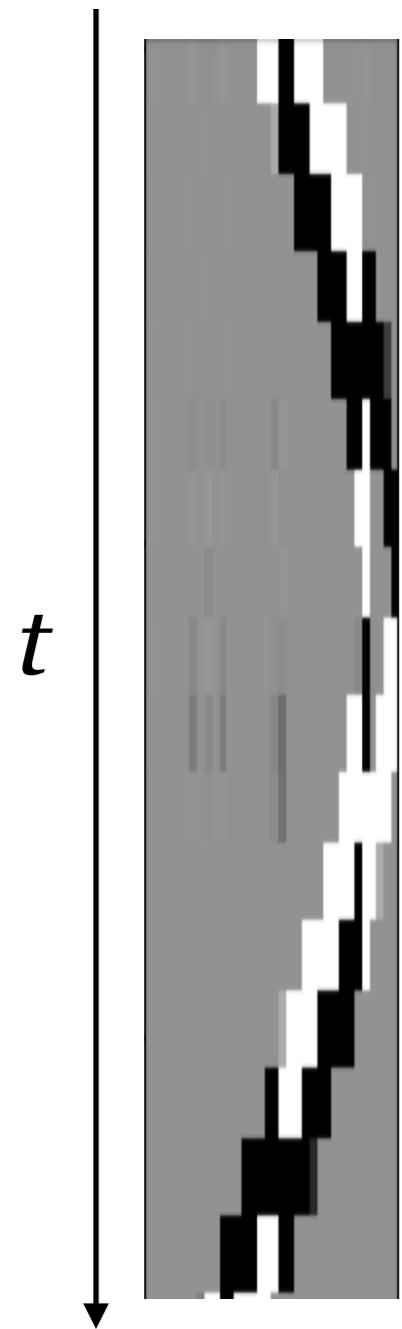


SNR = 40 dB

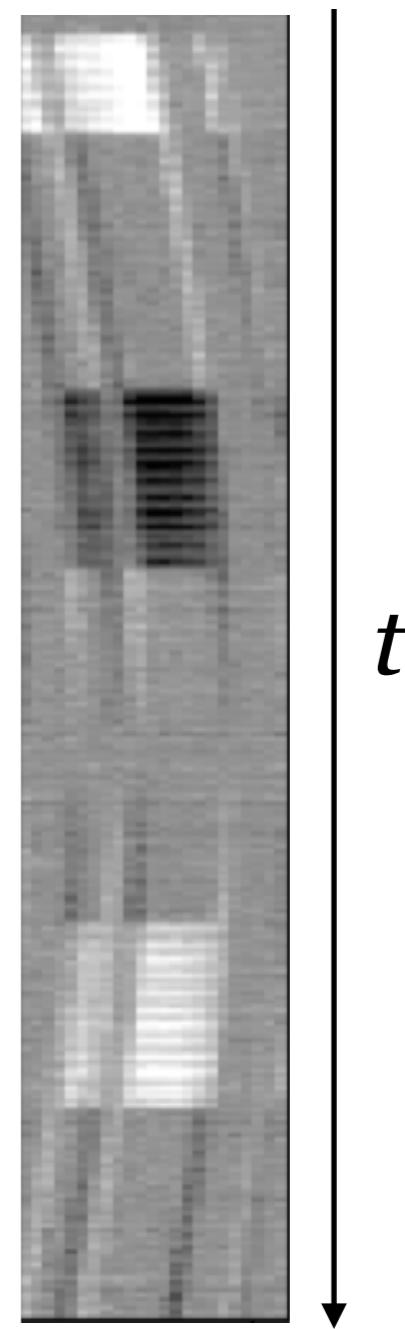
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Experimental setup

Ground truth
scene movie
(post time derivative)



Experimental
observation
(post time derivative)



Ground truth occluder



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Recovered occluder



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