

# The Gerchberg Saxton Algorithm

*and learning to speak to nanorobots*

# Bigger Goal

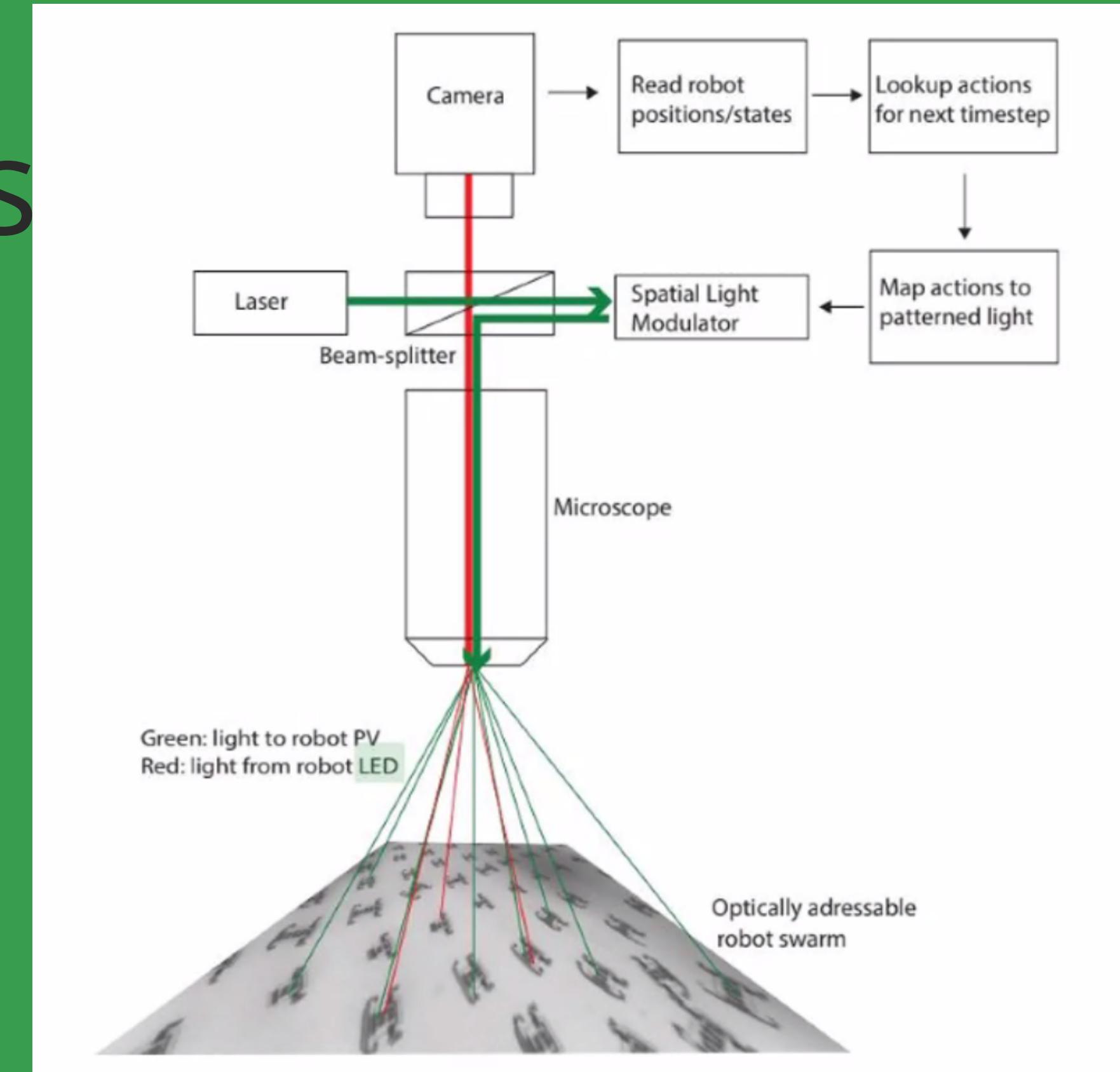
## Controlling swarms of nanorobot

**How?**

*Projecting patterns of light to control  
their motion*

*This needs **Dynamic, Quick, Precise**, programming of light*

**How?**



# An iterative phase retrieval algorithm

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## Known Information

We have 2 known amplitude arrays

Projected Pattern - Target Plane

Fourier Pattern - Source Plane

## Random Phase Guesses

Iterates until phase mask is accurate

## The Fourier Transform

The 2 different planes are separated by fourier transform

Every point in the source plane is the superposition of all points in the target plane

Every point in the source plane gives us a different interference scenario between all the points in the target plane

*Interference reveals the phase information*

# Pseudocode

**Let:**

FT – forward Fourier transform

IFT – inverse Fourier transform

$i$  – the imaginary unit,  $\sqrt{-1}$  (square root of  $-1$ )

exp – exponential function ( $\exp(x) = e^x$ )

Target and Source be the Target and Source Amplitude planes respectively

A, B, C & D be complex planes with the same dimension as Target and Source

Amplitude – Amplitude-extracting function:

e.g. for complex  $z = x + iy$ ,  $\text{amplitude}(z) = \sqrt{x \cdot x + y \cdot y}$

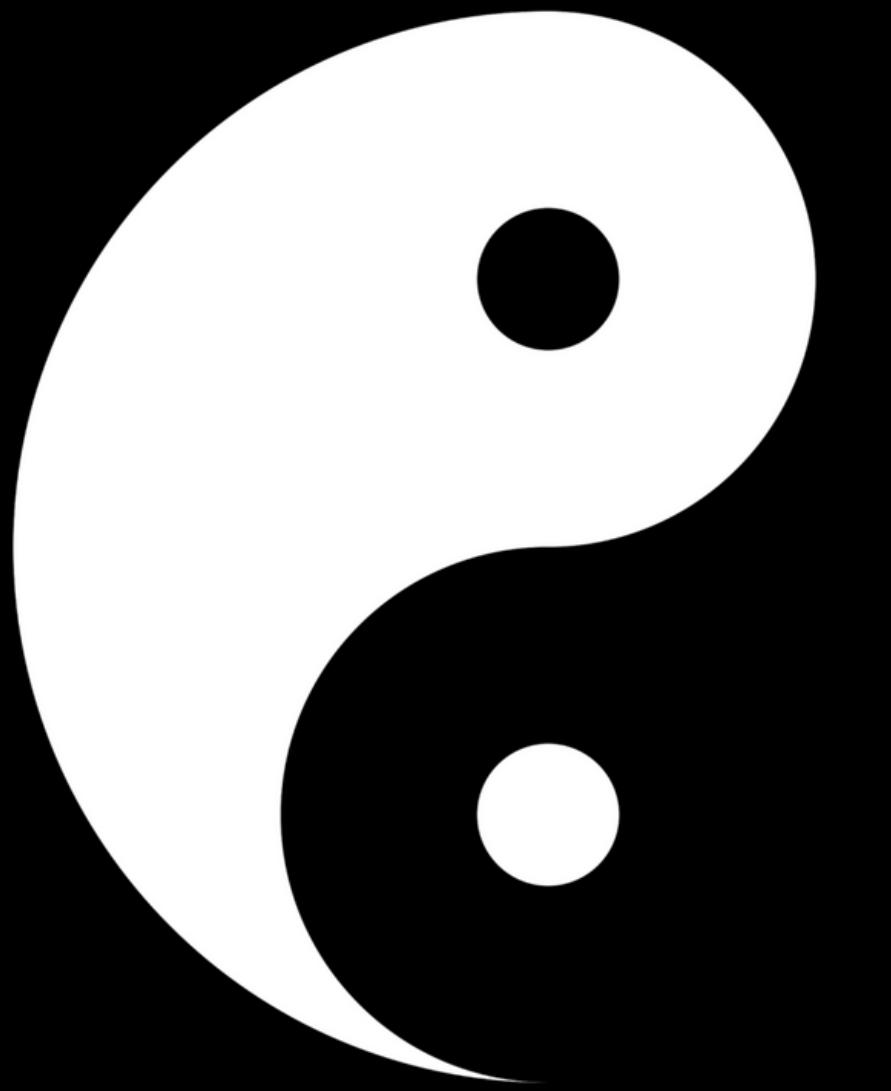
for real  $x$ ,  $\text{amplitude}(x) = |x|$

Phase – Phase extracting function:

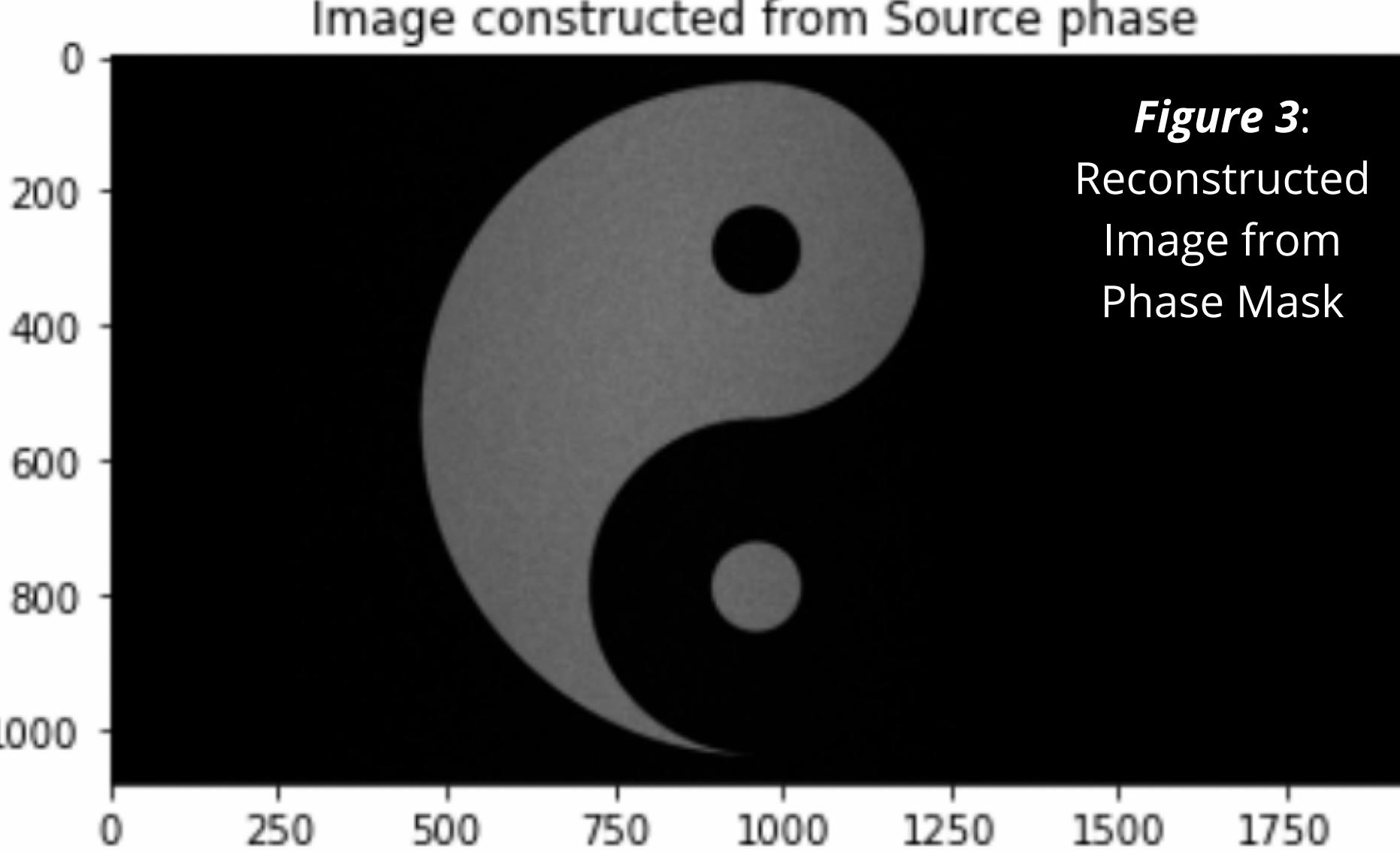
e.g.  $\text{Phase}(z) = \arctan(y / x)$

**end Let**

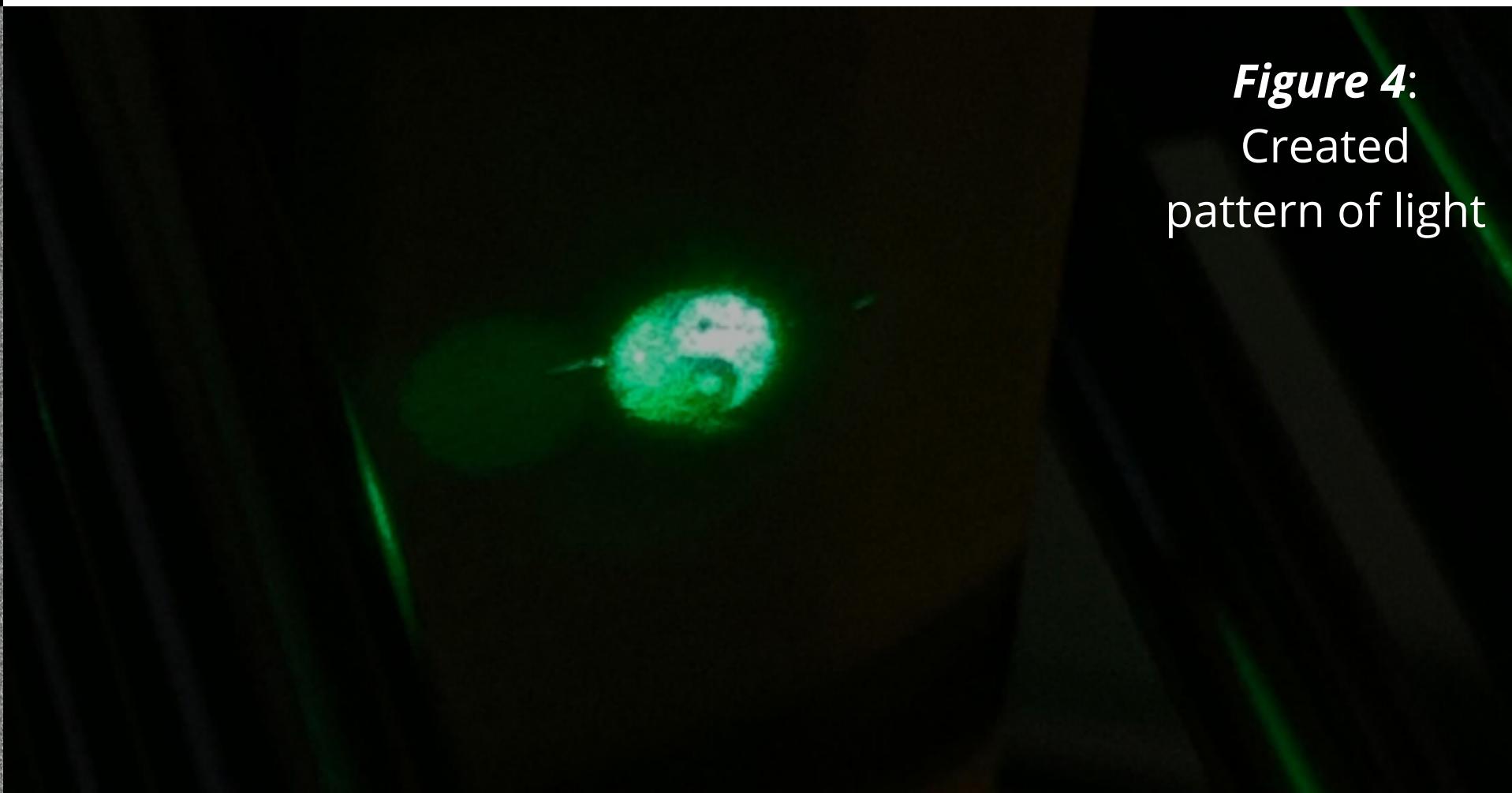
```
algorithm Gerchberg–Saxton(Source, Target, Retrieved_Phase) is
    A := IFT(Target)
    while error criterion is not satisfied
        B := Amplitude(Source) × exp(i × Phase(A))
        C := FT(B)
        D := Amplitude(Target) × exp(i × Phase(C))
        A := IFT(D)
    end while
    Retrieved_Phase = Phase(A)
```



**Figure 1:**  
Pattern that  
we want to  
project



**Figure 3:**  
Reconstructed  
Image from  
Phase Mask



# The End

*Thank you!*