



**ipfn**  
INSTITUTO DE PLASMAS  
E FUSÃO NUCLEAR

*MSc Engineering Physics*

# **Modeling Chaos in Cold Atom Physics with Explainable Artificial Intelligence**

2<sup>nd</sup> Cycle Integrated Project in Engineering Physics

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Supervisors: Professor Hugo Terças and Professor Rui Henriques

# Magneto-Optical Trap (MOT)

## Objective:

Cool and trap  $\sim 10^9$   $^{85}\text{Rb}$  atoms

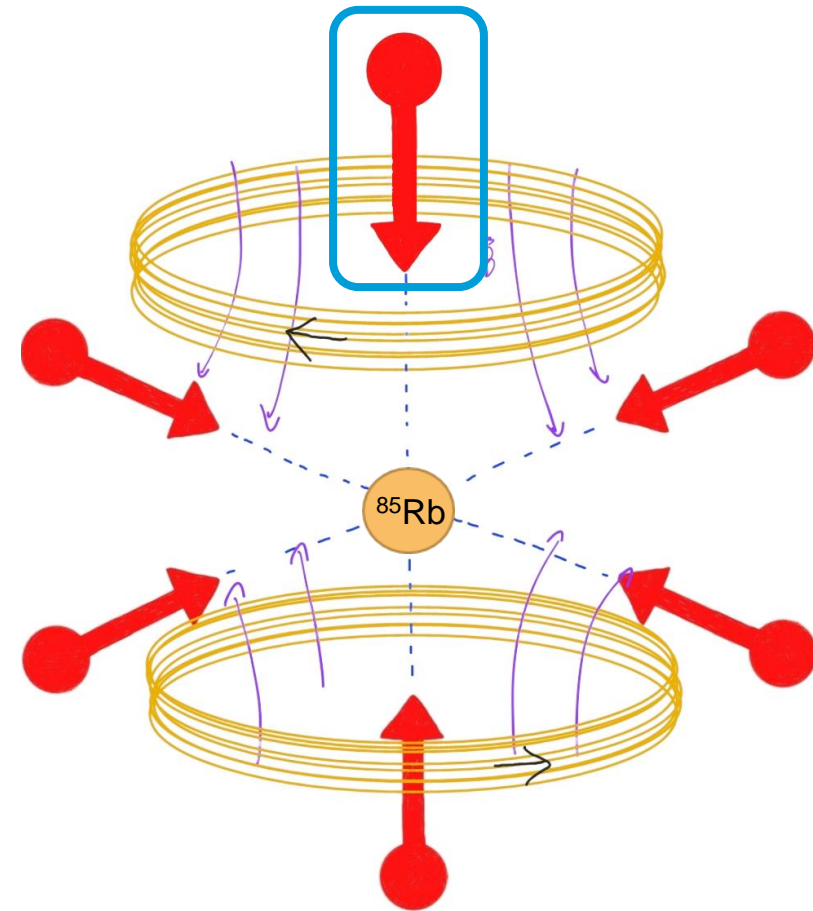
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## Mechanisms:

1. Doppler Cooling



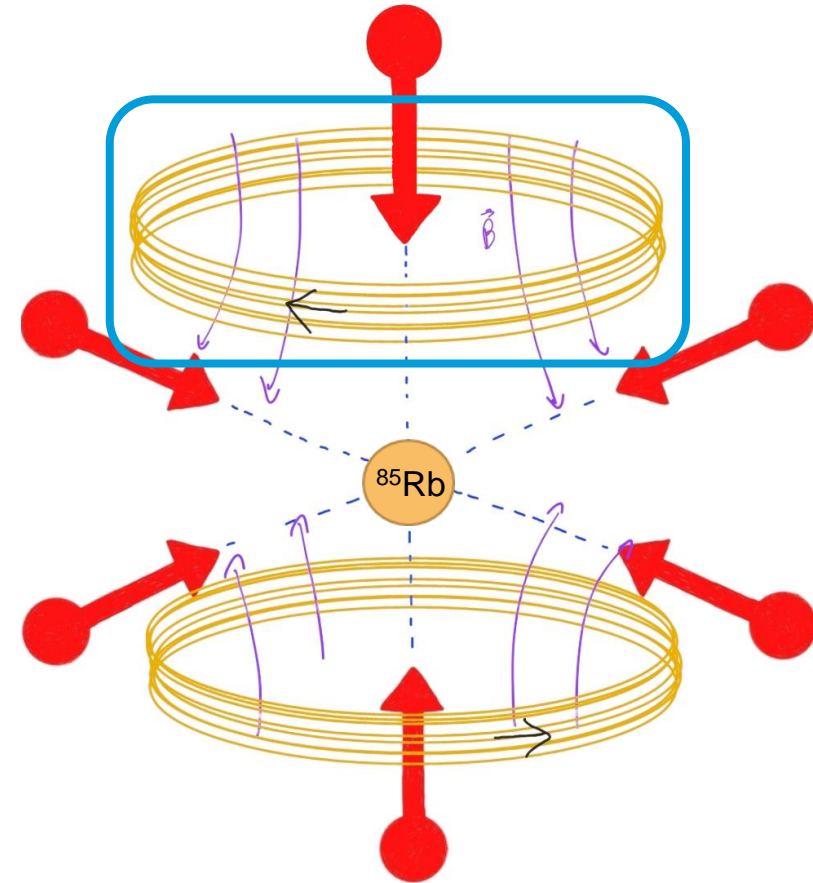
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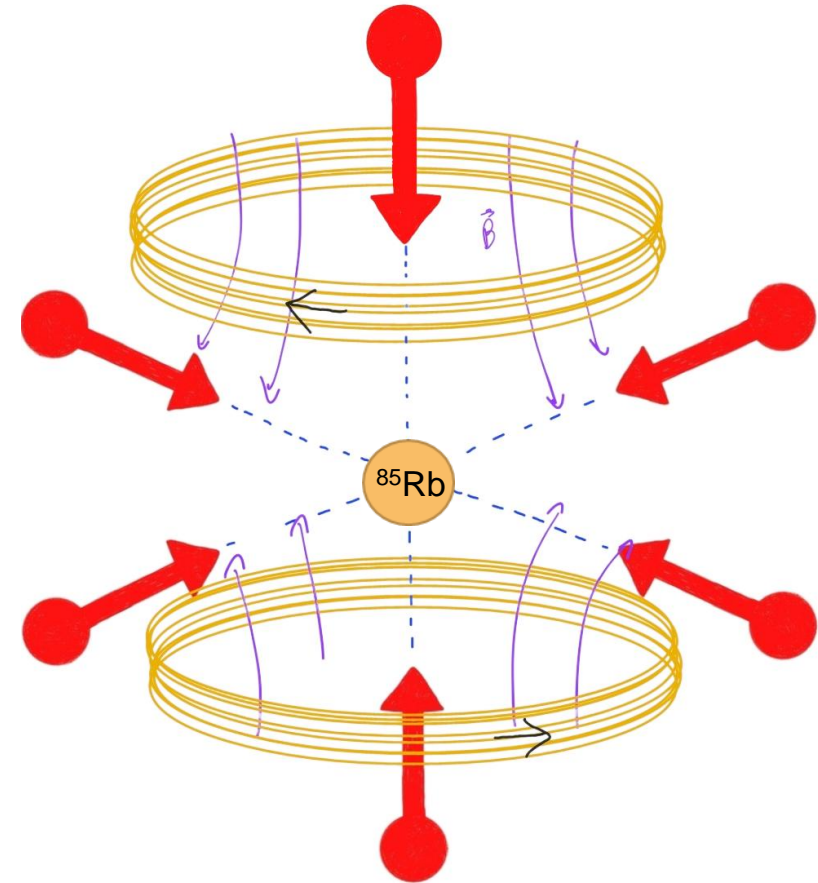
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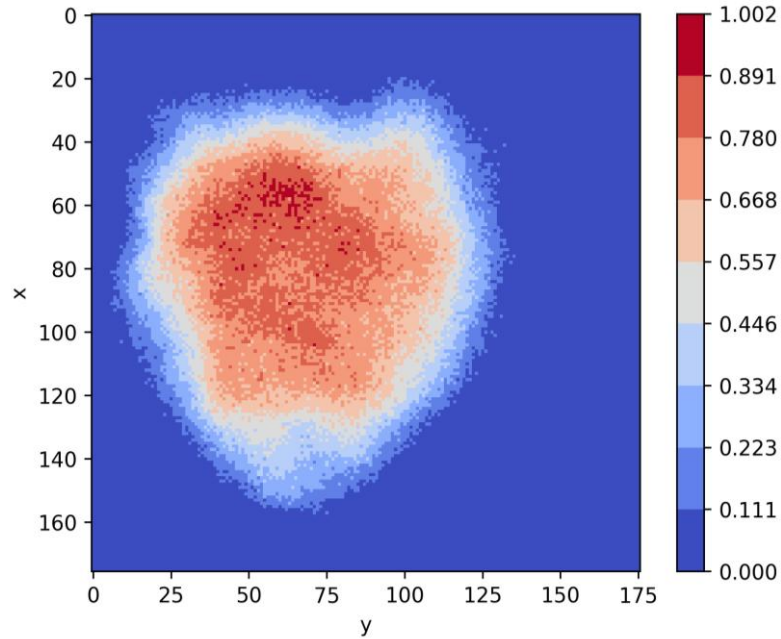
## The **detuning** parameter ( $\delta$ ):

$\delta \in \{-4\Gamma, -3.75\Gamma, \dots, -0.75\Gamma, -0.5\Gamma\}$ , with  $\Gamma \simeq 2\pi \times 6.1$  MHz  
 $\Gamma$  the natural linewidth of the  $D_2$  transition of  $^{85}\text{Rb}$

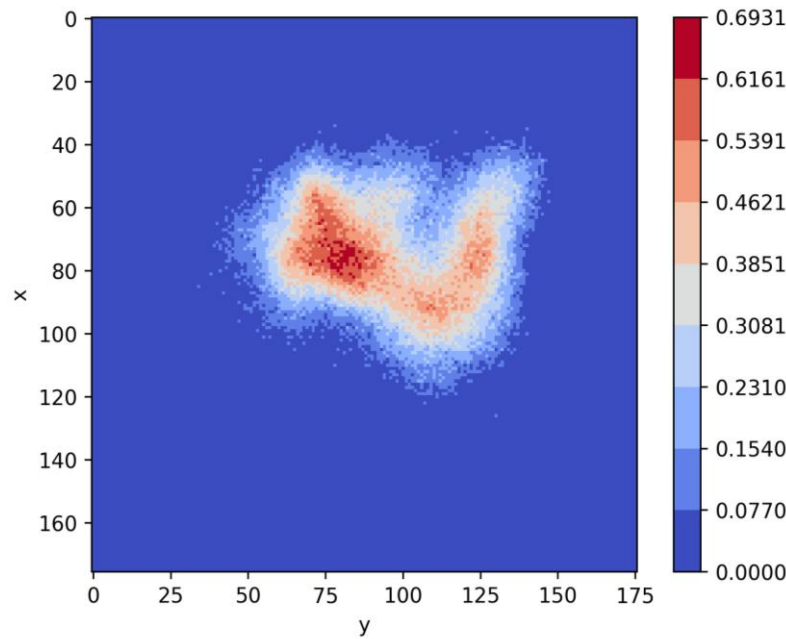


	<b>Purpose</b>	<b>Number of images per detuning</b>	<b>Time interval (ms)</b>	<b>Resolution</b>	<b>Pixel values</b>	<b>Dimensions</b>
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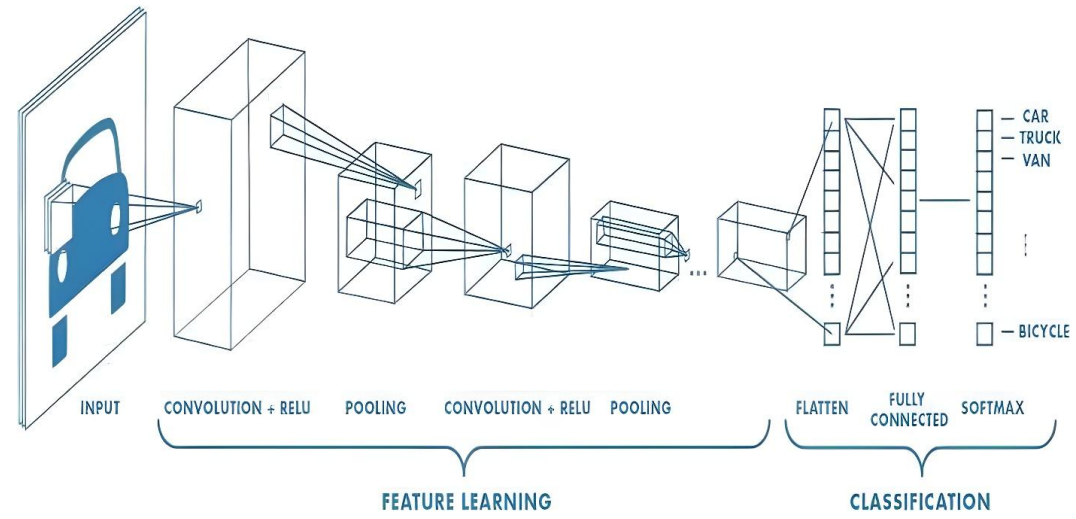
$\delta = -3\Gamma$



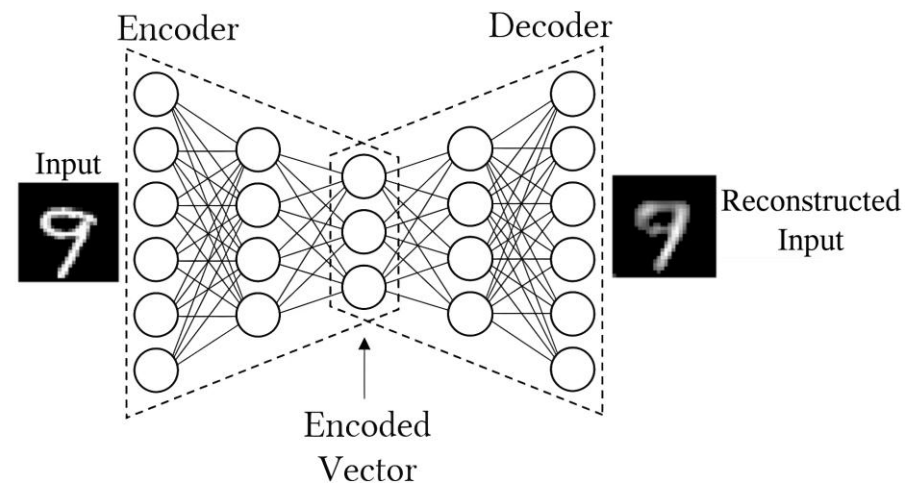
$\delta = -1\Gamma$

# Convolutional Autoencoders

## Convolutional Neural Network (CNN)



## Autoencoder



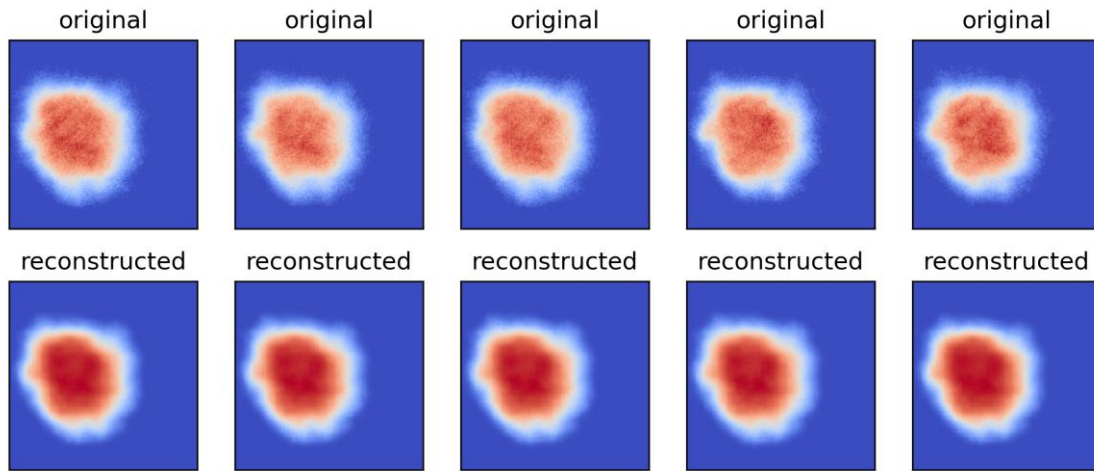








$\delta = -3.75\Gamma$



$\delta = -2\Gamma$

