
THIS THURSDAY 8.9.16
"RELAXATION
of the weak scale".
Hierarchy problem of Higgs mass is discussed HERE
" No need to be a theorist, no registration fee "
A talk by
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DESY

# Relaxation of the weak scale.

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**DESY, 8th September 2016**

HELMHOLTZ GEMEINSCHAFT

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# Overview

Hierarchy problem

Relaxation model

Double Scanner Mechanism

Superradiance





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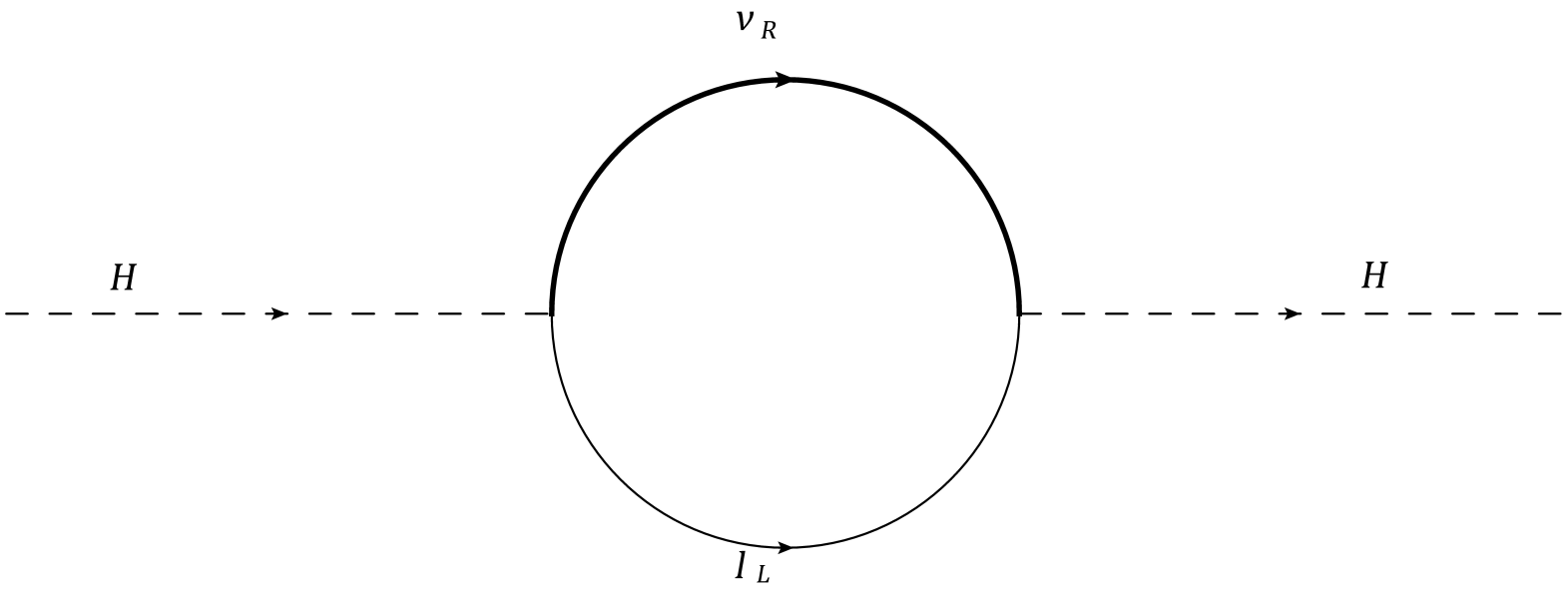
# Hierarchy problem

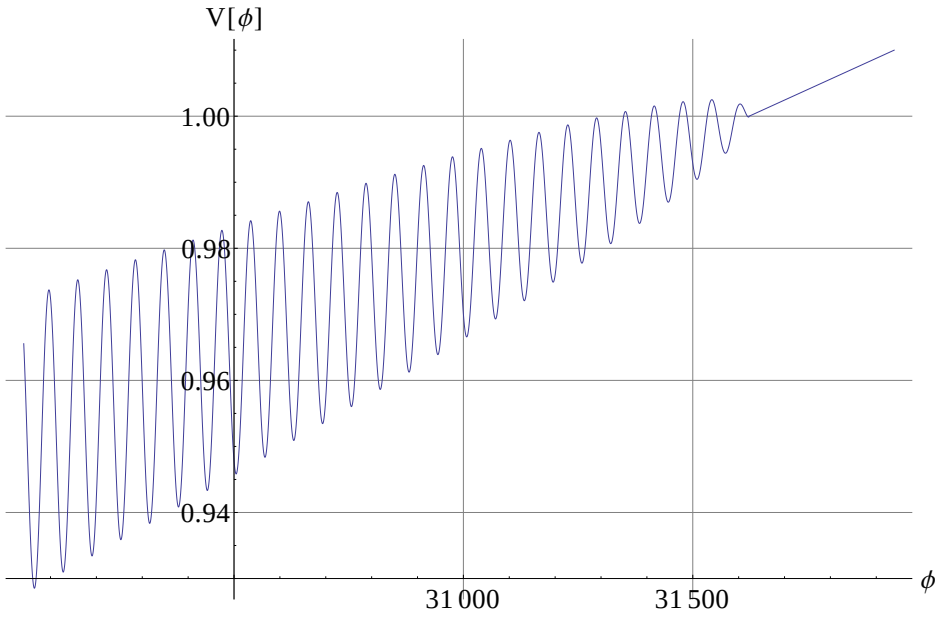



$$m^2_{\phi,eff} = m^2_\phi - \frac{y^2}{8\pi^2} M^2$$

# Relaxation model. Potential.

$$V(\phi, h) = \lambda h^4 + (-M^2 + g\phi)h^2 + gM^2\phi + \Lambda^4 \cos(\phi/f)$$

$$h(\phi) = \begin{cases} \sqrt{\frac{M^2 - g\phi}{2\lambda}}, & \phi < \frac{M^2}{g} := \phi_c \\ 0 & \text{otherwise.} \end{cases} \quad , \quad \Lambda^4 = \mu^3 h$$



# Relaxation model. Constraints.

Friedmann equation: $\ddot{\phi} + 3H_I\dot{\phi} + V'_\phi = 0$

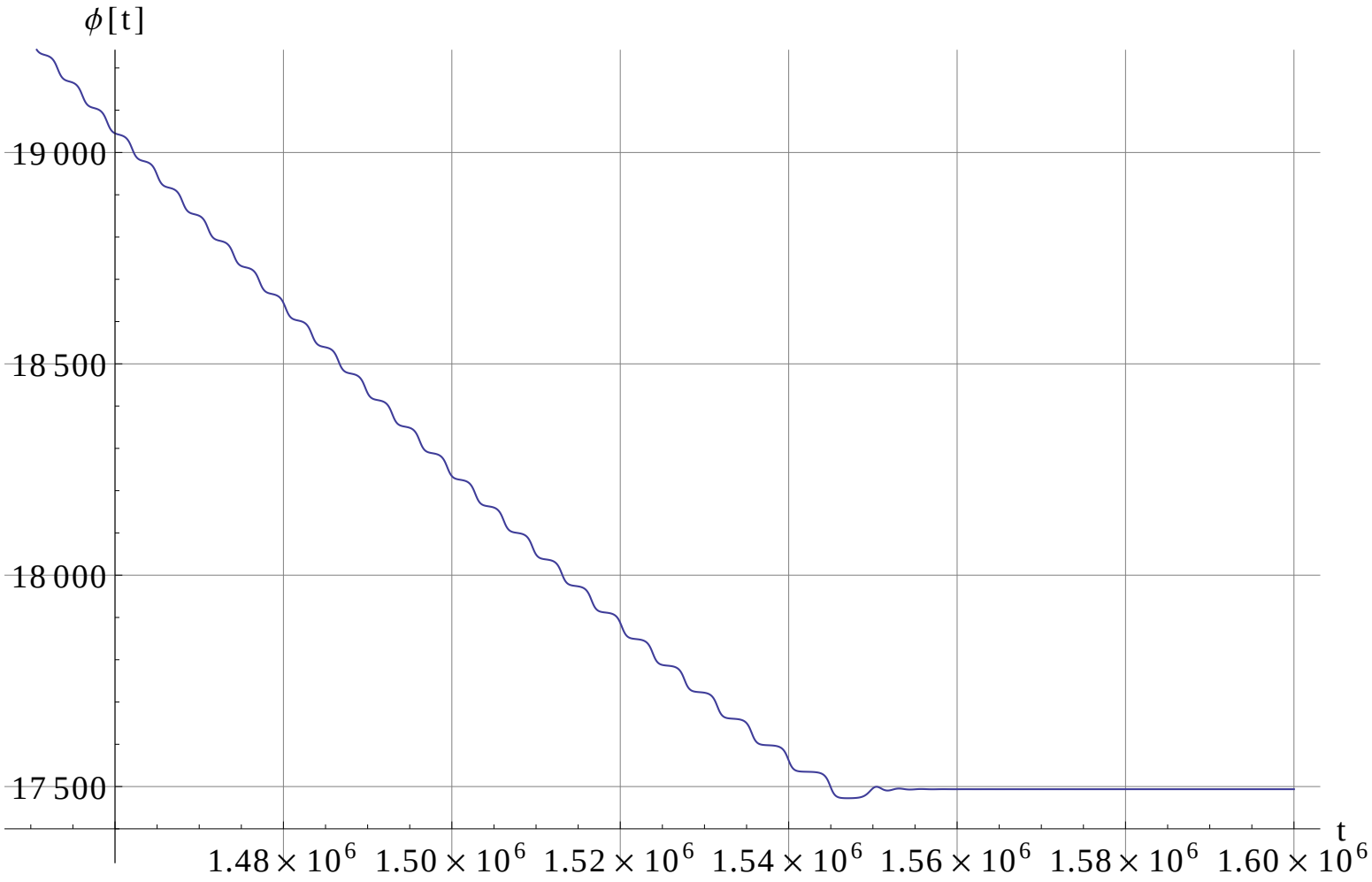
Vacuum energy: $\rho_{\text{inf}} \gtrsim \rho_\phi \implies H_I \gtrsim \frac{M^2}{M_{pl}}$

Slow-roll: $\frac{(\dot{\phi})^2}{2} \ll \rho_\phi \implies \begin{cases} g \ll H_I \\ g \ll H_I^2 \frac{M_{pl}}{M^2} \end{cases}$

Classical rolling: $H_I \lesssim (gM^2)^{1/3}$

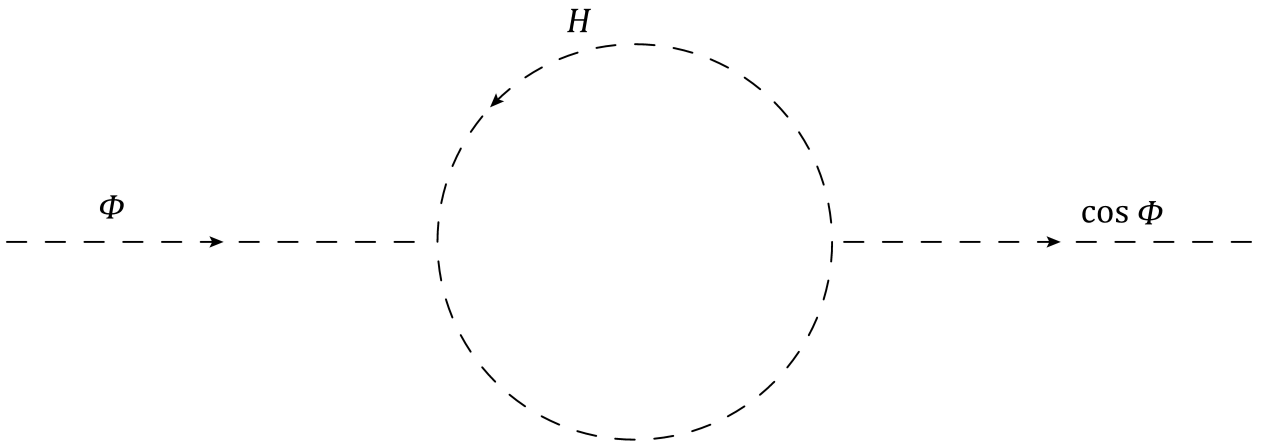
Stop at: $v \sim \frac{gM^2 f}{\mu^3}$

# Relaxation model. Dynamics.



# Double Scanner Mechanism.

$$\sim |H| \;\rightarrow\; \sim |H|^2$$




$$\sim \epsilon g \Lambda^3 \phi \cos(\phi/f)$$

# Double Scanner Mechanism. Potential.

$$V(\phi,\sigma,H)=\Lambda^4(\frac{g\phi}{\Lambda}+\frac{g_\sigma\sigma}{\Lambda})-\Lambda^2(\alpha-\frac{g\phi}{\Lambda})|H|^2+A(\phi,\sigma,H)\cos(\phi/f)$$

$$A(\phi,\sigma,H)=\epsilon\Lambda^4\left(\beta+c_\phi\frac{g\phi}{\Lambda}-c_\sigma\frac{g_\sigma\sigma}{\Lambda}+\frac{|H|^2}{\Lambda^2}\right)$$

$$H^2(\phi)=\begin{cases}\frac{\Lambda^2\left(\alpha-\frac{g\phi}{\Lambda})\right)}{2\lambda}, & \phi>\frac{\Lambda}{g}\alpha\\ 0 & \text{otherwise.}\end{cases}$$





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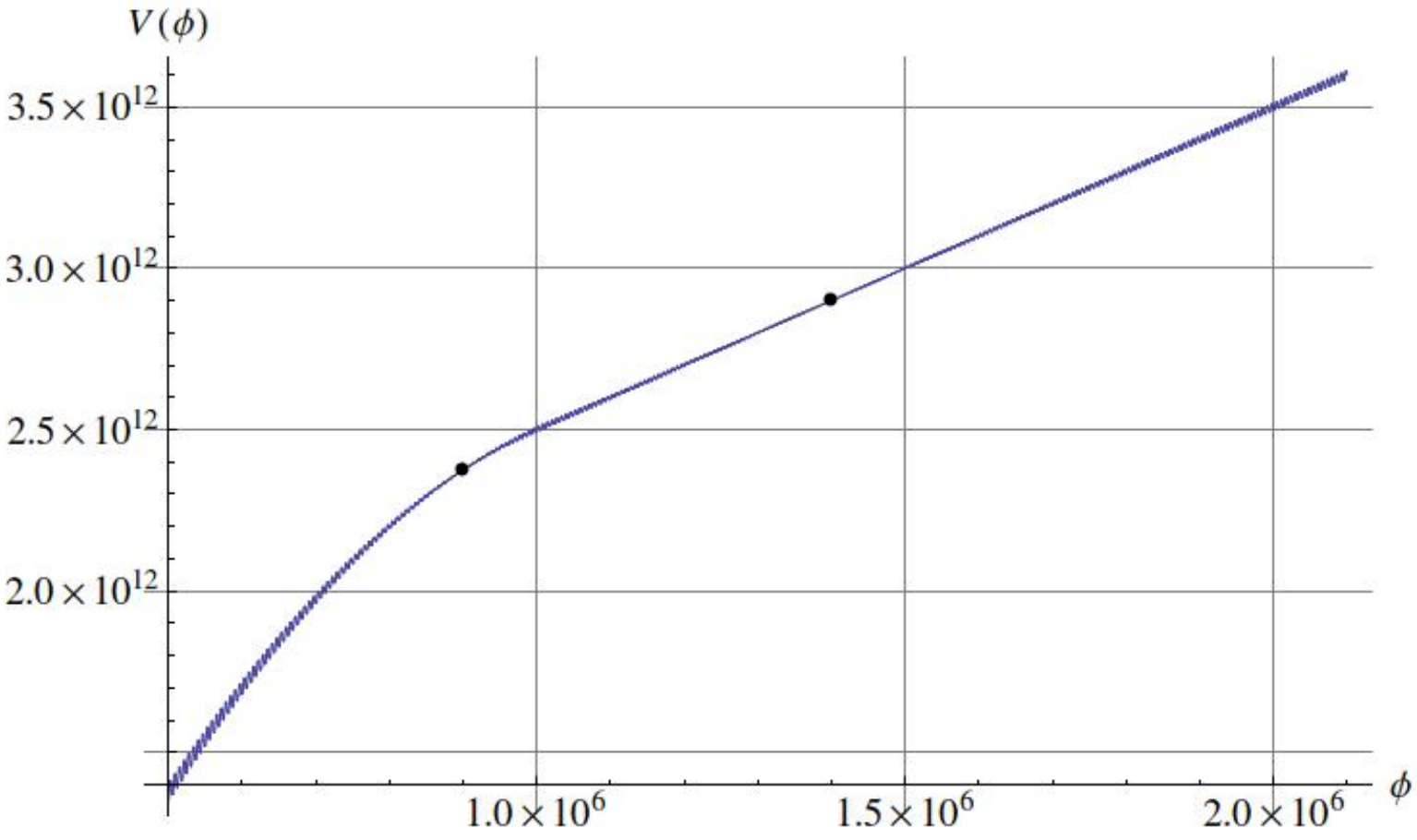
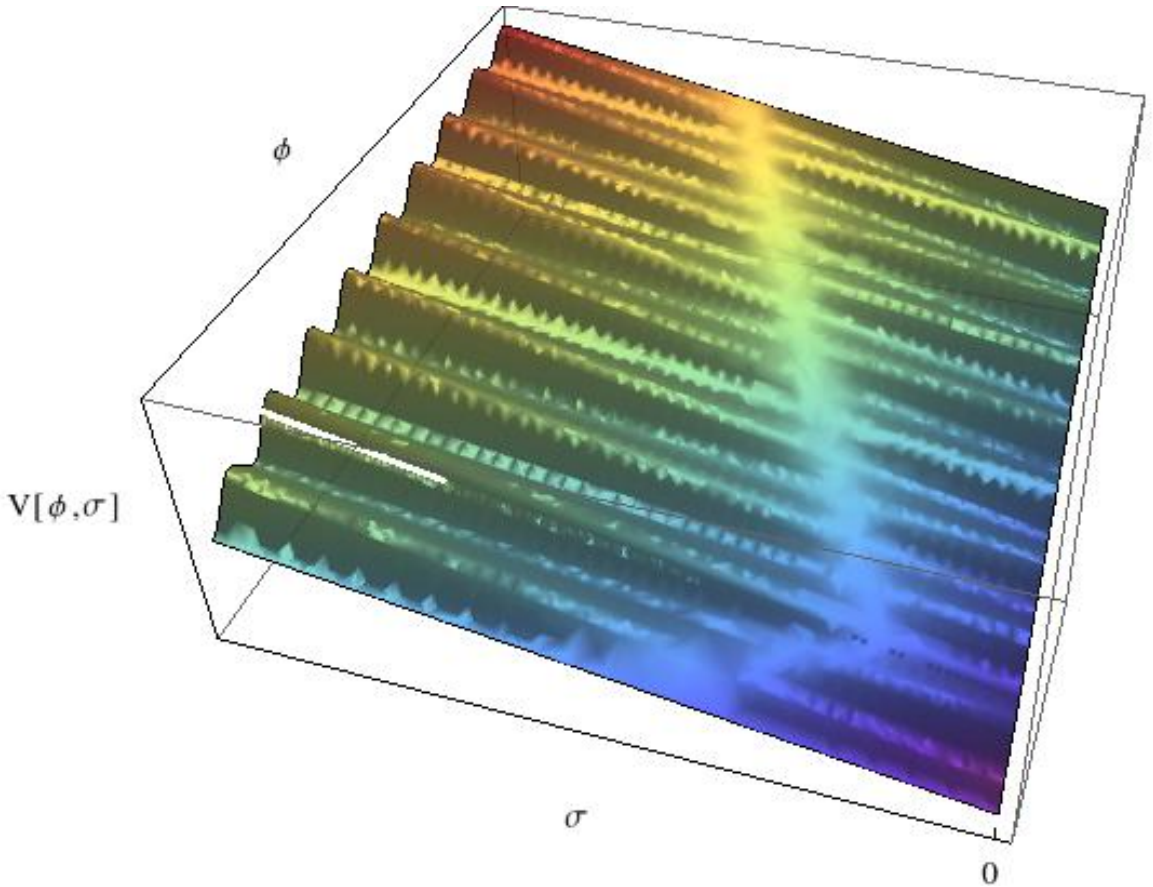
# Double Scanner Mechanism. Potential.



# Double Scanner Mechanism. Dynamics.





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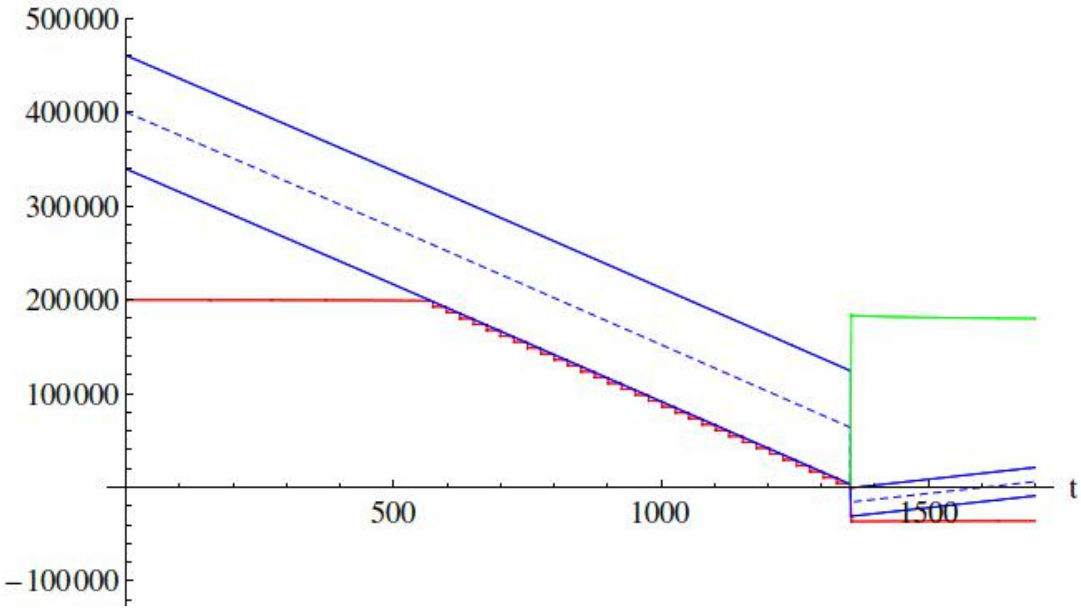
# Double Scanner Mechanism. Dynamics.





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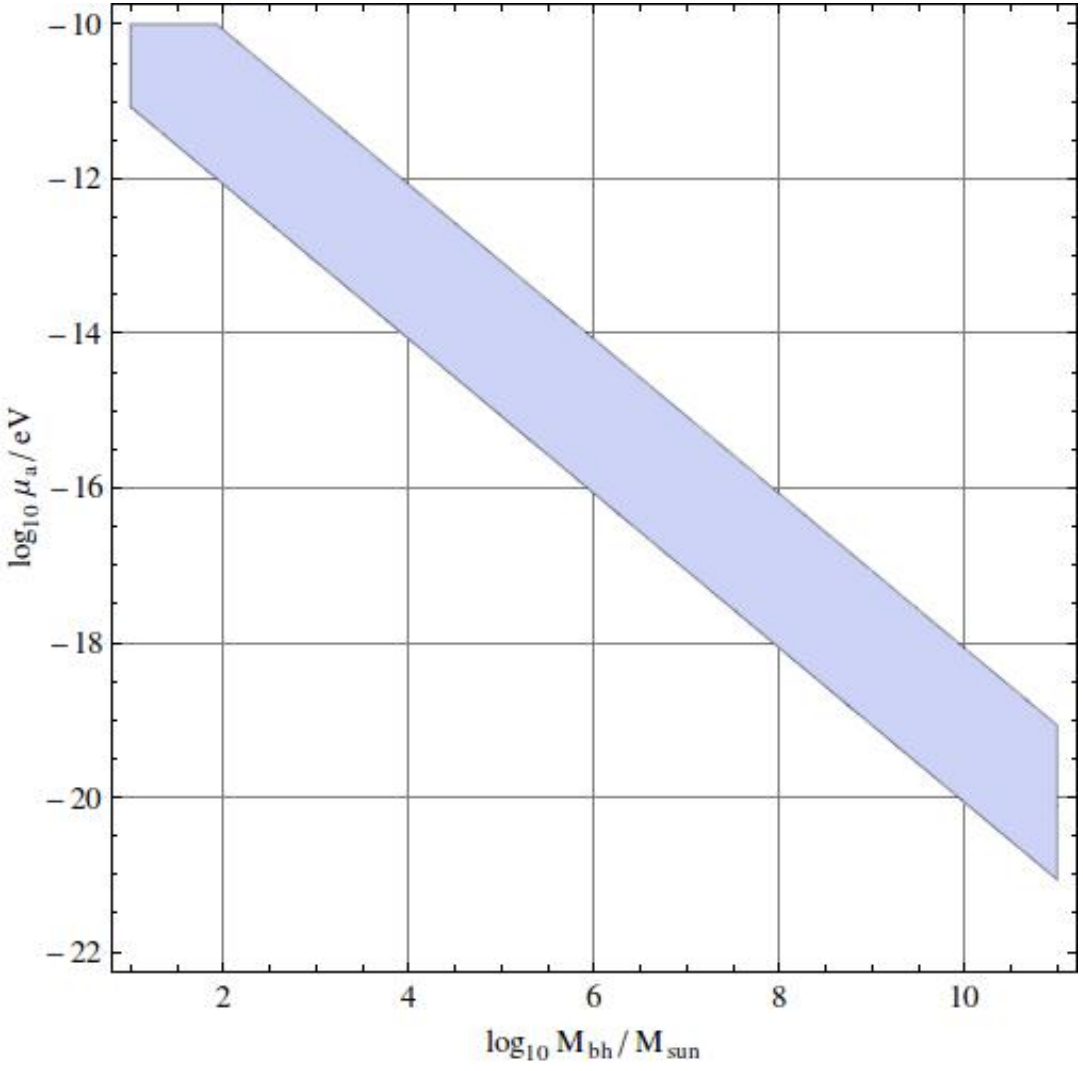
# Double Scanner Mechanism. Movie.

# Superradiance.





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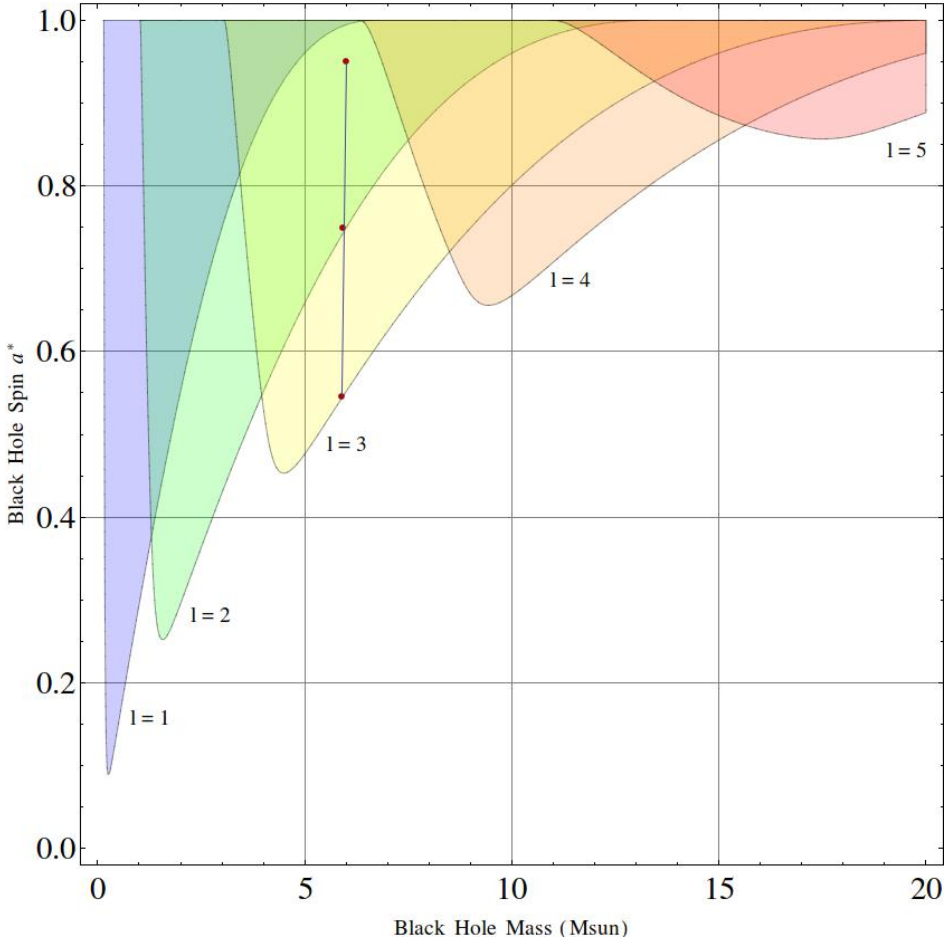
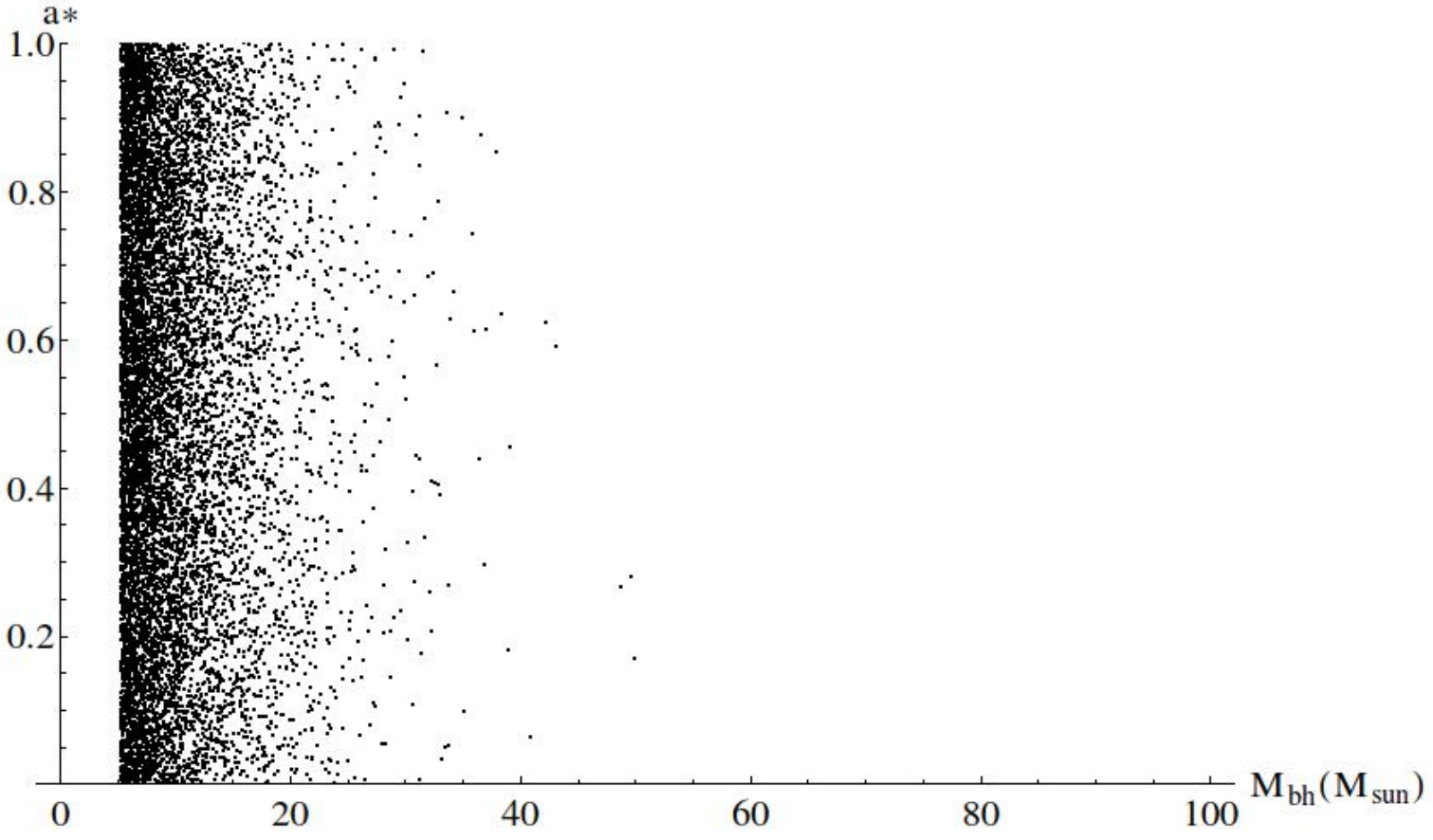
# Superradiance. Dynamics.

Superradiance: $\frac{dN}{dt} = \Gamma_{sr} N$ Annihilation: $\frac{dN}{dt} = -\Gamma_a N^2$

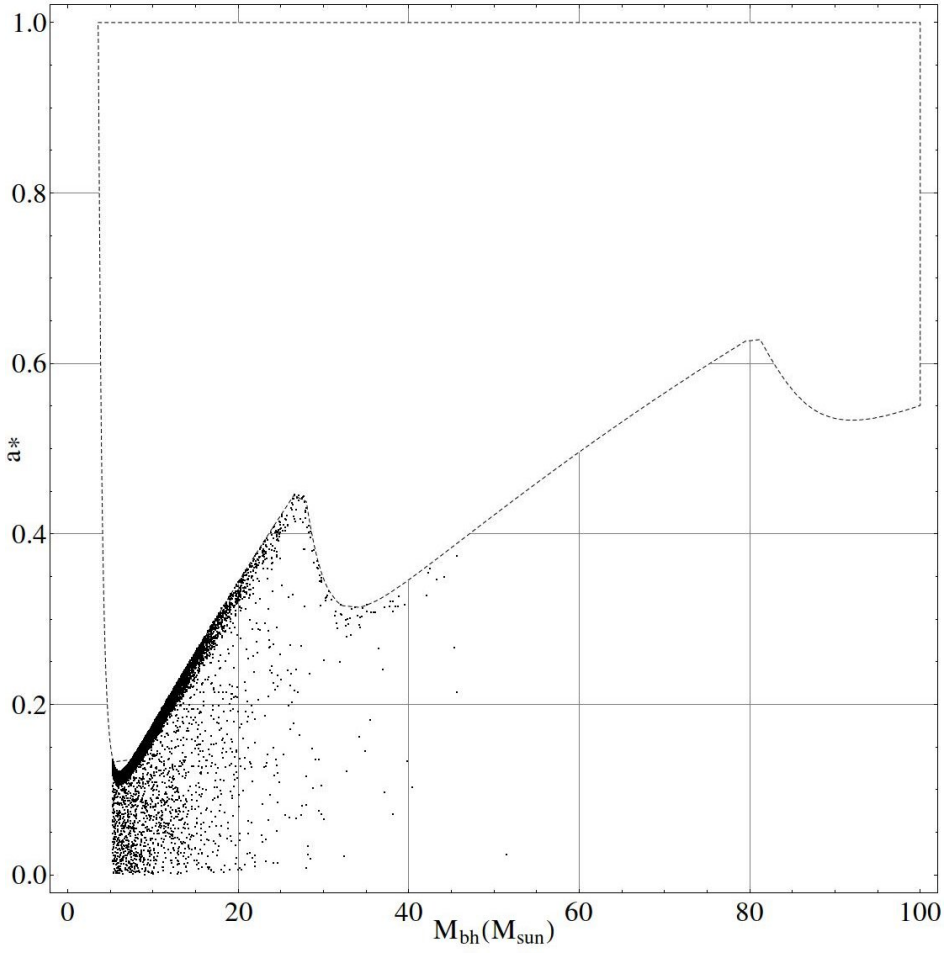


# Superradiance. BH distribution.

$$P(M) = M_0^{-1} e^{(M_{min}-M)/M_0}$$



# Superradiance. BH distribution with axions.





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# Conclusions.

# Questions & References I


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# Questions & References II



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