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The inflaton as dark matter

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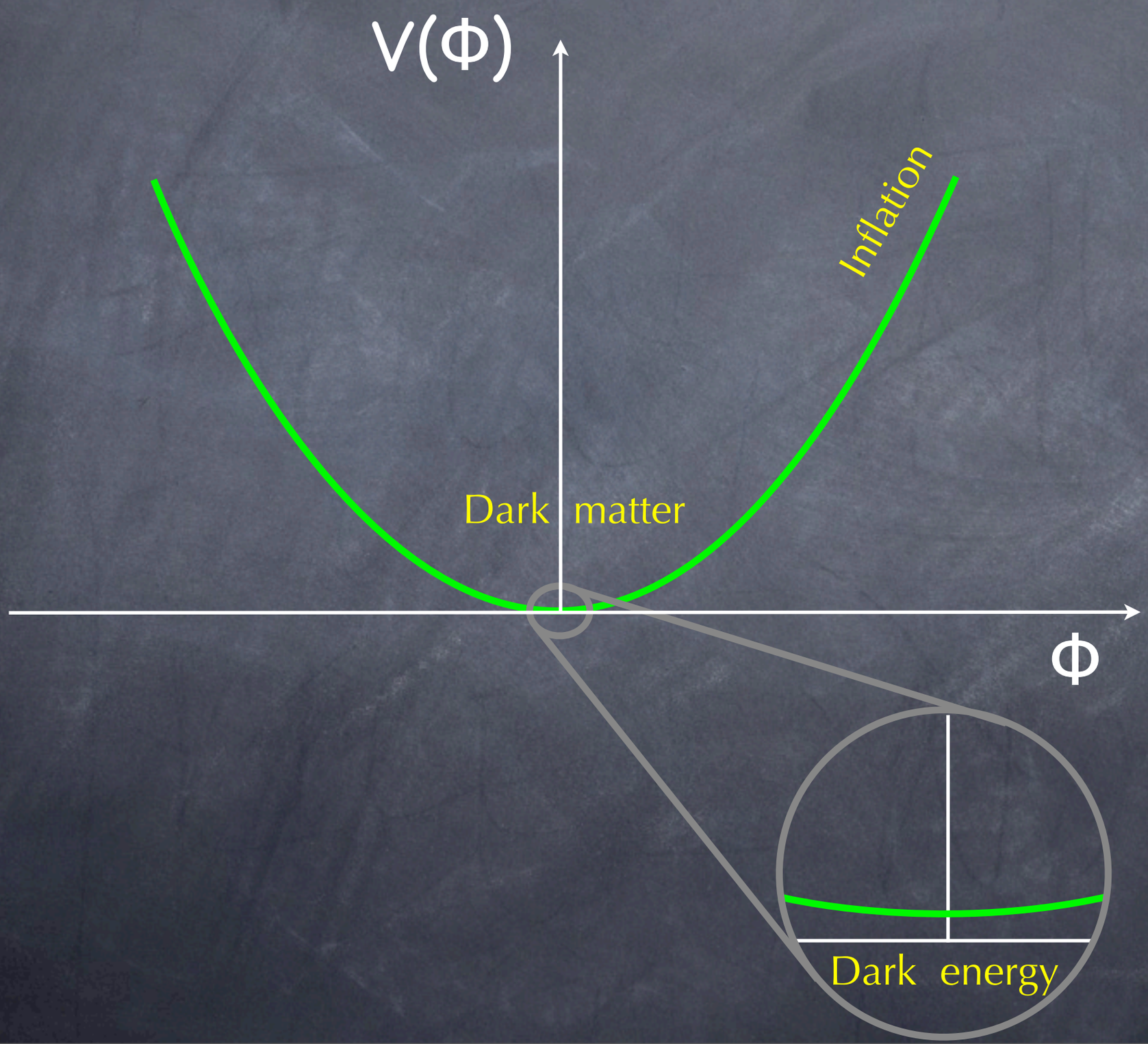
Microsoft-free presentation

Based on Liddle and Ureña-López,
astro-ph/0605205 (Phys Rev Lett)
and ongoing work with Pahud and Ureña-López

Unification scenarios



Observation

The dark matter mass per photon is observed to be

$$\xi \simeq 2.2 \times 10^{-28}\, m_{\rm Pl}$$

In the absence of decays, the evolution of the scalar field energy density is simply

$$\rho_\phi \simeq \text{const} \quad m^2 \ll H^2$$
$$\rho_\phi \propto 1/a^3 \quad m^2 \gg H^2$$

In practice the latter condition is already satisfied by the time inflation ends.

Usual belief: The inflaton decays away completely after inflation, making the field irrelevant. But can a residual oscillation survive as dark matter?

Precedent: Preheating with a quartic interaction $\Phi^2\chi^2$ rapidly reduces the oscillation amplitude from ~m_{Pl} to ~m/g, and then shuts off. However this residual oscillation is still far too large and in violation with observation.

Hence it is usually taken to be followed by trilinear preheating or conventional reheating, both removing the inflaton energy density completely as they correspond to inflaton decays.

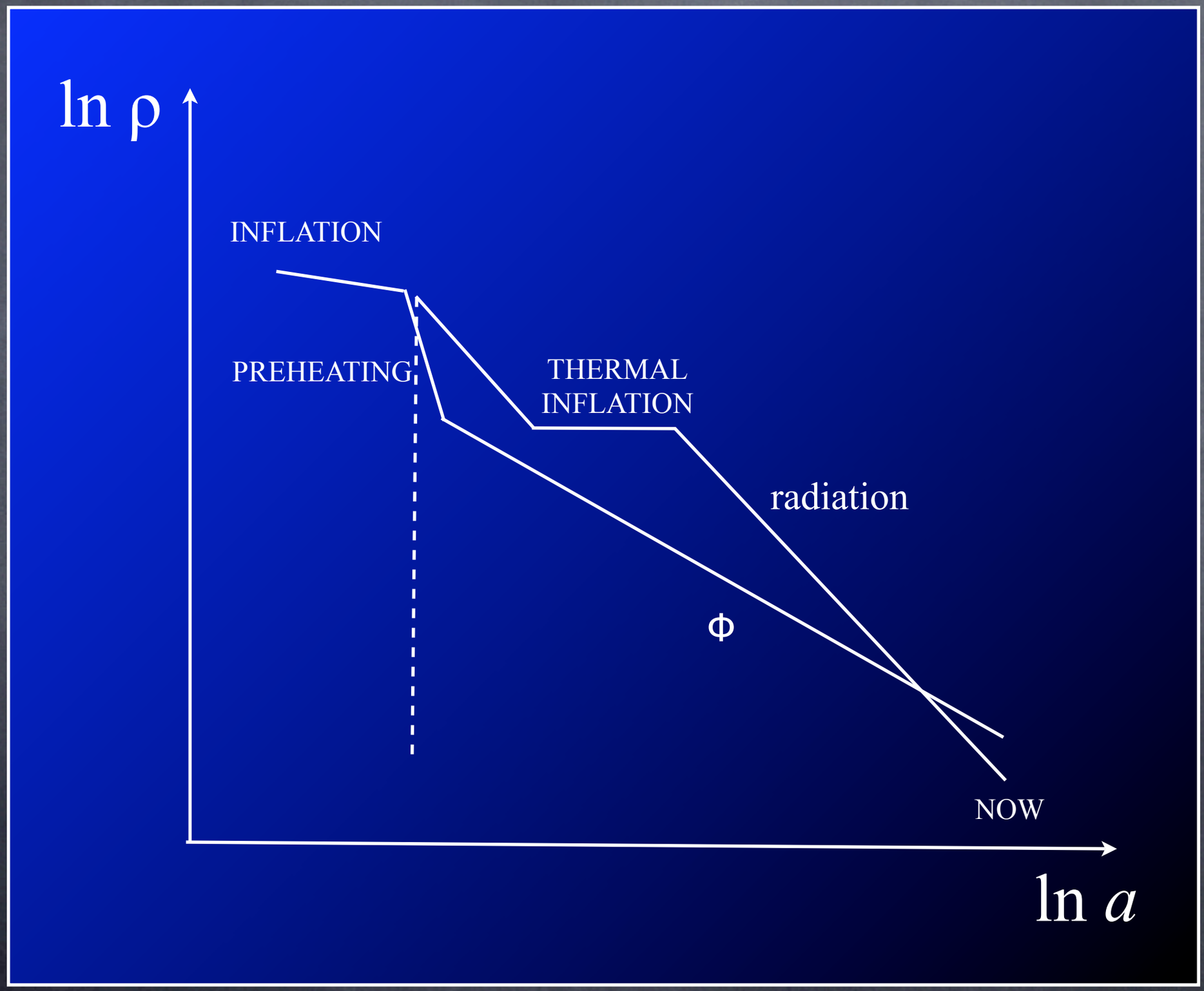
Unification scenarios

- Change the inflaton potential to try and get the field closer to the origin at the end of inflation. Doesn't work.

- Non-standard reheating mechanism.
  Reheat by annihilations rather than decays. Possible to make models but just phenomenological so far (ARL & Ureña-López).

- Modify the post-inflationary evolution.
  If radiation domination is interrupted, especially by thermal inflation, this can reduce the scalar field density to the desired level (ARL, Pahud & Ureña-López, imminent).

Universe history schematic



Conclusion

- At least in principle it appears possible to connect the inflation and dark matter epochs.
- Accordingly, the same scalar field potential could be responsible for inflation, dark matter and (in an anthropic string landscape sense) the dark energy.
- The basic scheme works for the quadratic potential, and should readily extend to the more realistic case of hilltop inflation.
- No attempt as yet to put in a physically-motivated context in terms of allowed and forbidden decay channels.