Inflation, Moduli, and TeV Physics

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Is there a way that we could test inflation at the Linear Collider?

traditional paradigms of inflation have difficulties:

"old" (Guth)

bubbles do not percolate, no exit

"new" (Linde, Albrecht-Steinhardt)

extremely flat potentials are needed: $\lambda < 10^{-15}$

There is a new paradigm: "new old" (Dvali-Kachru)

and the TeV scale plays a role!
Dvali-Kachru vision:

string moduli space is complicated. The universe made an excursion through this space before settling in the true vacuum.
explicit example

\[ V = m_{\Phi}^2 \Phi^2 + \lambda \Phi^2 \Psi^2 + \frac{1}{2} \alpha (\Psi^2 - m_{\text{Pl}}^2)^2 \]

with

\[ m_{\Phi}^2 \sim \frac{M^4}{m_{\text{Pl}}^2} \]
\[ \alpha \sim \frac{M^4}{m_{\text{Pl}}^4} \]

# of e-foldings

\[ N \sim \frac{1}{3} \log \frac{m_{\text{Pl}}^2}{m_{\Phi}^2} \sim \frac{1}{3} \log \frac{m_{\text{Pl}}^4}{M^4} \sim 50 \]

for \( M \sim 1 \text{ TeV} \)
generation of density fluctuations:

use the new mechanism of Dvali, Gruzinov, Zaldarriaga

additional field $\chi$ essentially massless during inflation

transfer $\chi$ energy to quarks and leptons during reheating

and efficient mechanism to mixing of $\chi$ and Higgs multiplet

\[
V_{\chi} = +m_h^2 h^{\dagger} h - c\bar{\Psi} \chi h^{\dagger} h
\]

\[c \langle \Psi \rangle \sim TeV\]

then,

\[
\chi \rightarrow h^0 \rightarrow W^+ W^- , \, t\bar{t} \rightarrow q, \ell, \gamma, g
\]
consequences for LC:

χ mixing with h leads to extra peaks in recoil in

\[ e^+e^- \rightarrow Z^0 + X \]

(observable to \( \sigma \sim 1\% \) of SM, 10% mixing)

χ and h should have the same branching ratios (unlike, e.g., Higgs-radion mixing)

supersymmetry may require additional singlets to raise the Higgs mass above 120 GeV;
this might be the reason they exist
summary:

a new scenario for inflation (Dvali-Kachru) has a preference for the TeV scale

the particle responsible for cosmic density fluctuations may be visible at the LC.