Creation of D9-brane—anti-D9-brane Pairs from Hagedorn Transition of Closed Strings

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- ## Hagedorn Temperature $\mathcal{T}_H$

  maximum temperature for perturbative string $Z(\beta) \to \infty$ for $\mathcal{T} > \mathcal{T}_H$

- ## Hagedorn Transition of Closed Strings (Atick-Witten etc.)

  Winding modes in the Euclidean time direction become tachyonic.

 A phase transition occurs due to the condensation of winding tachyon.

  We have not known the stable minimum of the potential.

- ## Brane-antibrane Pair Creation Transition (Hotta)

  Brane-antibrane pairs are unstable at zero temperature.

  D9-$\overline{\text{D9}}$ pairs become stable near the Hagedorn temperature.

  ➡ A phase transition occurs

  and D9-$\overline{\text{D9}}$ pairs become stable

  near the Hagedorn temperature.
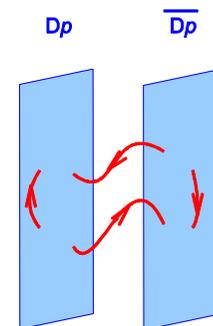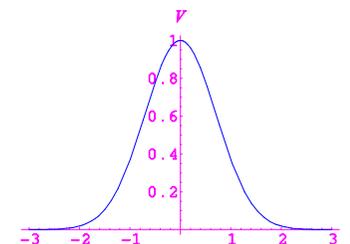
- **Thermodynamic Balance on D9-$\overline{D9}$ Pairs**

  Energy flows from closed strings to open strings.

  → Open strings dominate the total energy.

- **Relation between Two Phase Transition**

  Conjecture: D9-$\overline{D9}$ pairs are created

  by the Hagedorn transition of closed strings.

  We describe some circumstantial evidences for this conjecture.

- **Application to Cosmology**

  Lower-dim. D-branes are realized as topological defects through tachyon condensation.

  formation of our Brane World as a topological defect

  ↓ Randall-Sundrum model, Brane Gas Cosmology, ekpyrotic universe, KKLT model

  We study the homogeneous and isotropic tachyon condensation

  as a first step towards `Brane World Formation Scenario'.