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Dark Matter Particle Mass Estimation

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Abstract

In the inflaton spacetime model, the dark matter known to exist in the universe is an exotic particle, a resonance of a bound state of a point and an antipoint. By assuming that the bound state acts like a single point, and using the known ratios of baryons to photons and dark matter density to baryon density, we can estimate that the mass of the dark matter particle is approximately 5 TeV.

In the [inflaton spacetime model](#), spacetime consists of quantum entities called points. Points are mixed states—fermionic on some observations and bosonic on others. Points are identical and indistinguishable, so we can look at spacetime as two fields, one of fermionic points and one of bosonic points. The two fields are coupled because of the mixing. There are forward-time fermionic and bosonic fields and backward-time fermionic and bosonic fields.

Fermions obey Fermi-Dirac statistics: there is zero probability that any two identical fermions can occupy the same quantum state. The apparent force that keeps them apart is called *degeneracy pressure*. As a result, they form a lattice or Fermi gas, and because they are indistinguishable and spacetime looks the same whether they move or not, there is some probability that they do move. They have two velocity eigenvalues, zero (not moving) and the speed of light, c (moving). The vacuum expectation value of the electroweak Higgs field determines the ratio of 0 points to c points at any time tick. Over time, fermionic points can be mixtures of these two states, so they can have any velocity between zero and c .

As a result of the coupling to the fermionic field, the bosonic spacetime field feels a kind of friction derived from the degeneracy pressure felt by the fermionic field, so on any time tick some of the bosonic points will not be able to move. Therefore, like the fermionic points, which have two velocity eigenvalues, zero and c , the speed of light, the bosonic points also have two velocity eigenvalues, 0 and c . The bosonic spacetime field has its own version of the Higgs field, which settles to some vacuum expectation value that determines the ratio of bosonic 0 points to bosonic c points.

In bosonic spacetime, points can have any position. For spacetime to remain time neutral, there must be a guarantee that when a bosonic point moves, it will not remain in any position for more than one time tick unless it is paired with an opposite-time point wherever it lands. In other words, speed-of-light bosonic points, which have zero charge, are acceptable by themselves, but to guarantee time and therefore charge neutrality, stationary bosonic points must be paired—*every stationary forward-time bosonic point must be paired with a stationary backward-time bosonic point*. The two points form a *bound state*—they are tightly coupled electromagnetically. Moreover, they must always have the same position. The position of such a pair can only change through quantum fluctuations, which means that it can move, but very slowly. In the bosonic spacetime field, neither points nor particles can be in a mixed state of 0 and c eigenstates. Only pure velocity eigenstates are possible. This is because the 0 eigenstate is a bound pair of forward-time and backward-time points, so it cannot mix with points in the c eigenstate, which are single, unpaired points. The degeneracy pressure affects only the paired, stationary points. Thus, the inability of the 0 and c velocity eigenstates of bosonic points to mix splits the bosonic spacetime field into two separate fields. The quanta of one are extremely sluggish and feel degeneracy pressure, while the quanta of the other all move at the speed of light.

The Sloton

A particle is a resonance of a spacetime point. A bosonic resonance can be a forward-time or backward-time resonance or both. A resonance or particle is identified by a creation-time difference between a point and the global or observer's time. If the resonance is of an unpaired forward-time bosonic point, it is a photon and the resonating point moves at the speed of light. It is indistinguishable from a resonance of an unpaired backward-time point moving in the opposite direction. Therefore, the photon is its own antiparticle.

If the forward-time and backward-time points of a stationary bosonic point pair resonate, they do it as a single unit because they constitute a bound state, and the resonance is a stationary boson with zero charge and zero spin. No such particles are known to exist. However, it is possible in the inflaton spacetime model because the forward-time and backward-time components of a stationary point are collocated, so they can resonate synchronously. This particle cannot move at all, except for quantum fluctuations of its position, which means that it can move, but very slowly. I call it the *sloton*, for “slow photon.”

Sloton Mass

In the inflaton spacetime model, the mass of a point is the inverse of its position uncertainty. Obviously the sloton is very heavy because it is stuck in space except for quantum fluctuations of its position. The sloton is a resonance of a bound state of two points, a point and an antipoint (a point going backward in time). The two components are tightly bound to each other and resonate as a single point. The mass of a resonating point is twice the mass of the ground state, and the particle mass is the excess energy

above the ground state. Therefore, we will assume that the sloton's mass is equal to the ground state energy of the underlying point pair, which can be considered a single point.

A sloton point is stationary in time because one of its components is going forward in time and the other is going backward. The only way that this is possible is if neither component moves in time. This means that a sloton point is also stationary in space. Its components cannot move together, since an antipoint appearing to an observer to move in the same direction as a point is actually moving in the other direction, but backward in time. Thus, neither component can move.

In the inflaton spacetime model, both space and time are discrete and both are subject to quantum fluctuations. In other words, both the position of a given spacetime point and the time between ticks at that point can fluctuate. The theory of special relativity allows us to consider time to be regular and absorb all of the quantum randomness in the position quantum numbers. Usually, the model adopts this strategy. The time between regular time ticks is assumed to be equal to the Planck time, about 10^{-43} second. However, because time is discrete, there is uncertainty as to exactly when each component of a sloton point actually appears. The components can only be observed at time ticks, so there is a possibility that they could actually appear somewhere between regular time ticks. This means that the time the sloton point is stuck at is subject to quantum uncertainty and can fluctuate within a window equal to plus or minus the Planck time, for a window width of two Planck times. Since in the inflaton spacetime model time is considered regular and any quantum time uncertainty is observed as position uncertainty, the position of such a point has a quantum uncertainty within a window that is two Planck lengths wide in any direction, that is, a spherical window with a radius equal to the Planck length. The ground state energy of such a point is approximately $\pi/\sqrt{2} E_{\text{Pl}}$, where E_{Pl} is the Planck energy, 1.22×10^{19} GeV.

If all bosonic points were stationary, they would all have this energy and we could say that the mass of the sloton is approximately the Planck mass. (In this note, we use natural units—the speed of light c is 1. Thus energy and mass are equal and are measured in GeV.) If all bosonic points were moving at the speed of light, they would all be massless. Let us define the dark matter Higgs field as a scalar field that takes the value $\pi/\sqrt{2} E_{\text{Pl}}$ for a sloton point pair and the value zero for a speed-of-light point. This field will evolve towards the lowest possible energy, which would be zero except that, as we have explained, some bosonic points must be stationary, so the field settles at some ratio of sloton points to speed-of-light points that is greater than zero. This ratio times $\pi/\sqrt{2} E_{\text{Pl}}$ we call the *vacuum expectation value of the dark matter Higgs field*, w . The universe will maintain this ratio by creating new bosonic points in the proper proportions. Note that this is different from the electroweak Higgs field, whose vacuum expectation value is maintained by changing stationary fermionic points to speed-of-light points and vice versa. This doesn't work in the bosonic spacetime field because stationary bosonic points and speed-of-light bosonic points don't mix. But since enormous numbers of new points are continually being created and most new points are bosonic, there are ample resources available to maintain a constant w .

To calculate the ground state energy of a sloton point (pair), which is also the mass of the sloton particle, we have to estimate its position uncertainty. If all bosonic points were stationary, we could use the value found above. But there are many more speed-of-light bosonic points than stationary points. Let's say there are z_{sp} sloton points per speed-of-light point. Then,

$$w = z_{sp}\pi/\sqrt{2} E_{Pl}.$$

The vacuum expectation value w is the average energy per bosonic point. It sets a limit on how precisely we can locate a sloton point, and that limit is $1/w$. A sloton point can't appear to have a mass-energy any greater than w . In fact we can't locate a sloton point even that precisely. There are $1/z_{sp}$ photon points to every sloton point. In other words, the smallest volume of space that can contain one sloton point is $1/z_{sp}$ times the volume occupied by the sloton point itself, which we have estimated to be the spherical volume corresponding to an energy of $\pi/\sqrt{2} E_{Pl}$. The location precision we seek is the radius of the corresponding volume, proportional to the third root of the volume. Therefore, we must reduce the mass limit w by a factor equal to the third root of the volume ratio, which is just z_{sp} . So we can estimate the mass of the sloton to be:

$$m_s = (z_{sp})^{1/3} w = \pi/\sqrt{2} E_{Pl}(z_{sp})^{4/3}.$$

This doesn't yet get us where we want to be, since we don't know what z_{sp} is. However, with one more assumption, we do have some data that will get us there. The assumption is that the ratio of sloton particles to photons is the same as the ratio of sloton points to photon (speed-of-light) points. We can then write:

$$m_s = [(baryon\ mass)(baryons/photon)(photons/cm^3)(\rho_{DM}/\rho_b)]/[(photons/cm^3)z_{sp}],$$

where ρ_{DM}/ρ_b is the ratio of the dark matter energy density of the universe to the baryon energy density and is known to be about 6. Most baryons are protons and neutrons and have a mass of about 1 GeV. There are 10^9 photons per baryon. Therefore, the sloton mass is:

$$m_s = 6(10^{-9})/z_{sp}.$$

Now we can equate the last two equations and find that:

$$z_{sp} = 1.29 \times 10^{-12}.$$

and

$$m_s = 4670\text{ GeV}$$

This seems like a ridiculously large mass, but it is based on assumptions that seem reasonable, and it is probably testable at the Large Hadron Collider. Once the LHC

reaches its design collision energy of 14 TeV, any event that has a large missing transverse energy of around 5 TeV has probably created a dark matter ston.