Title: What's Blowing up the Universe?

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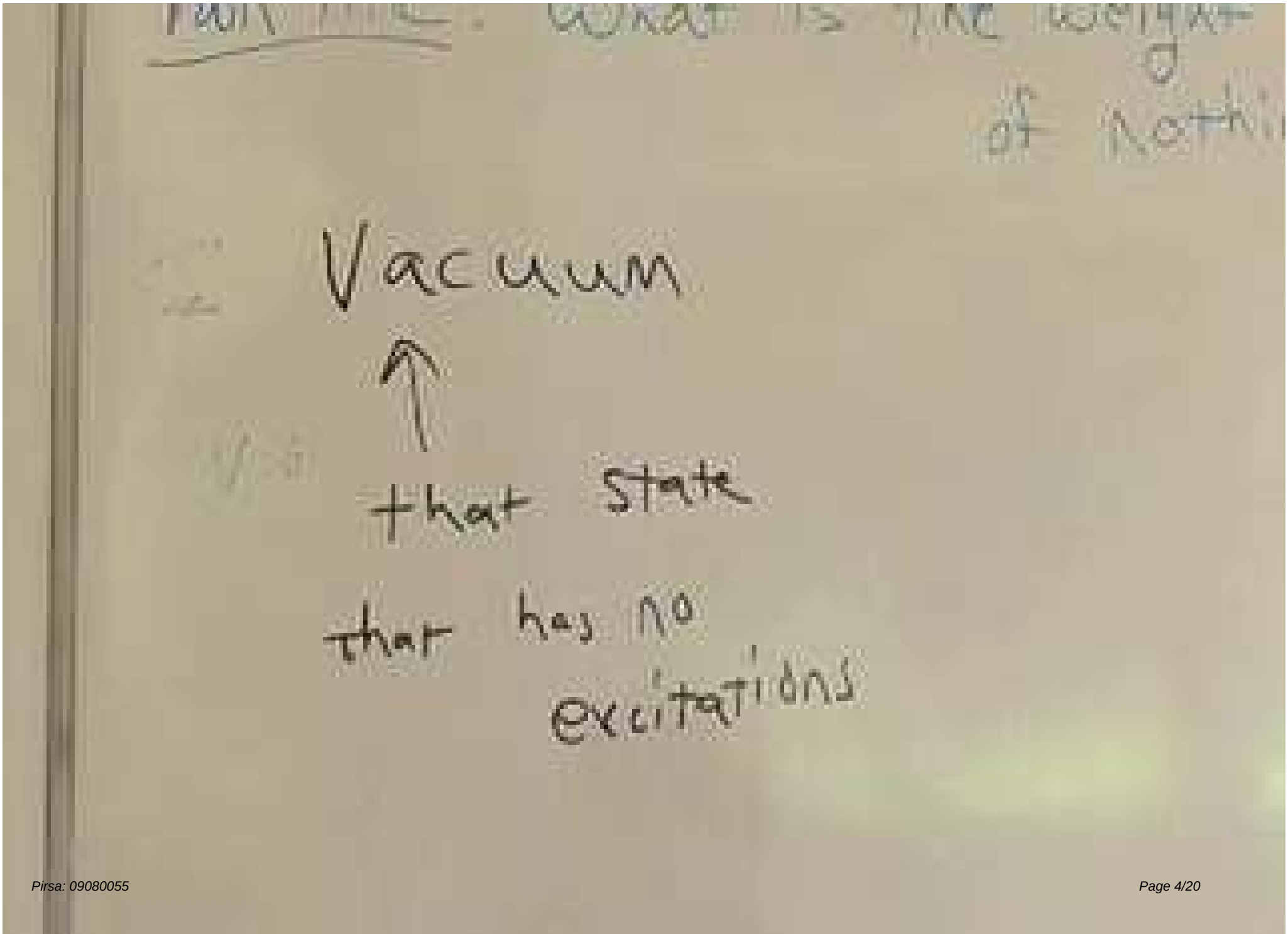
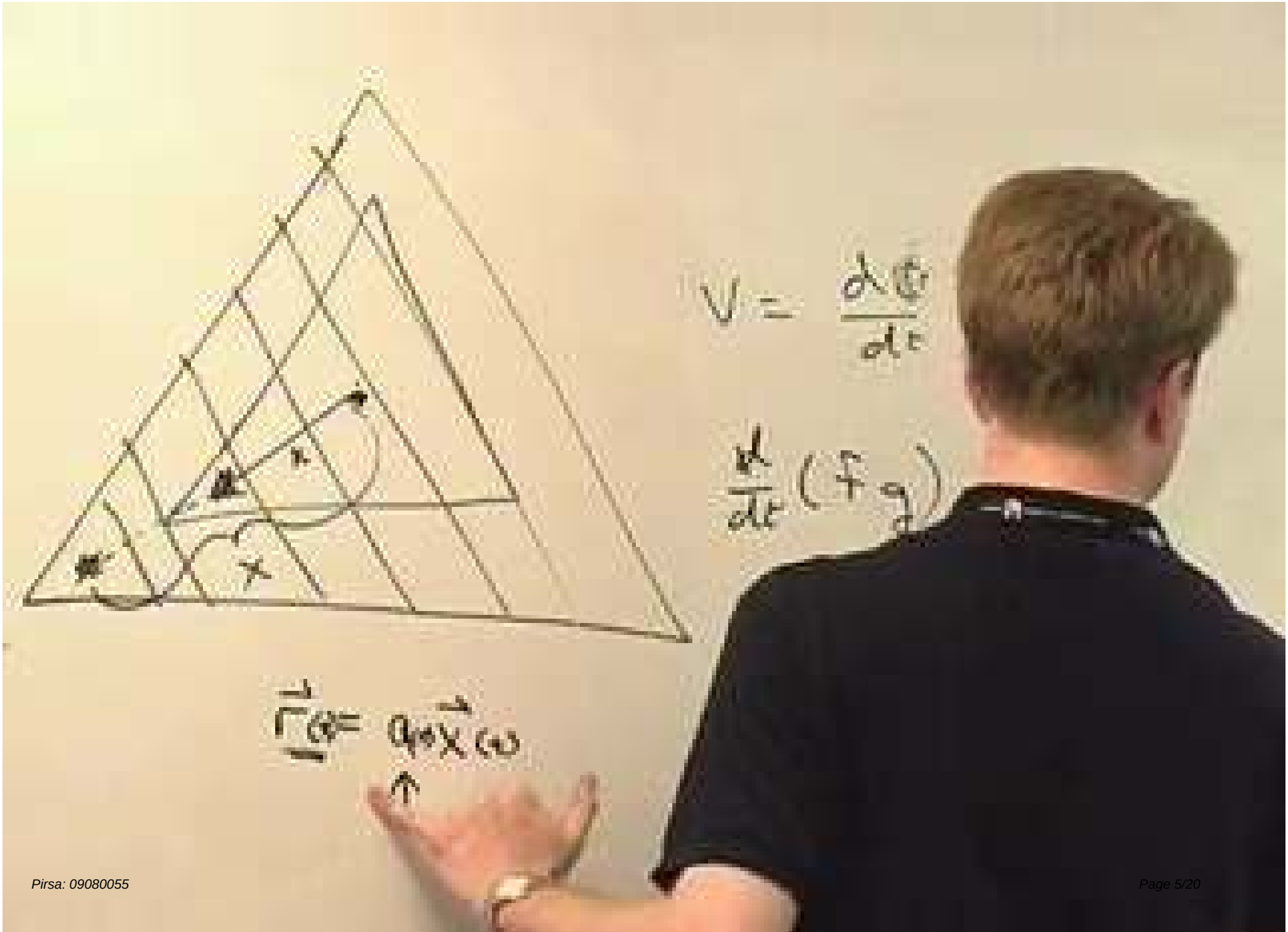
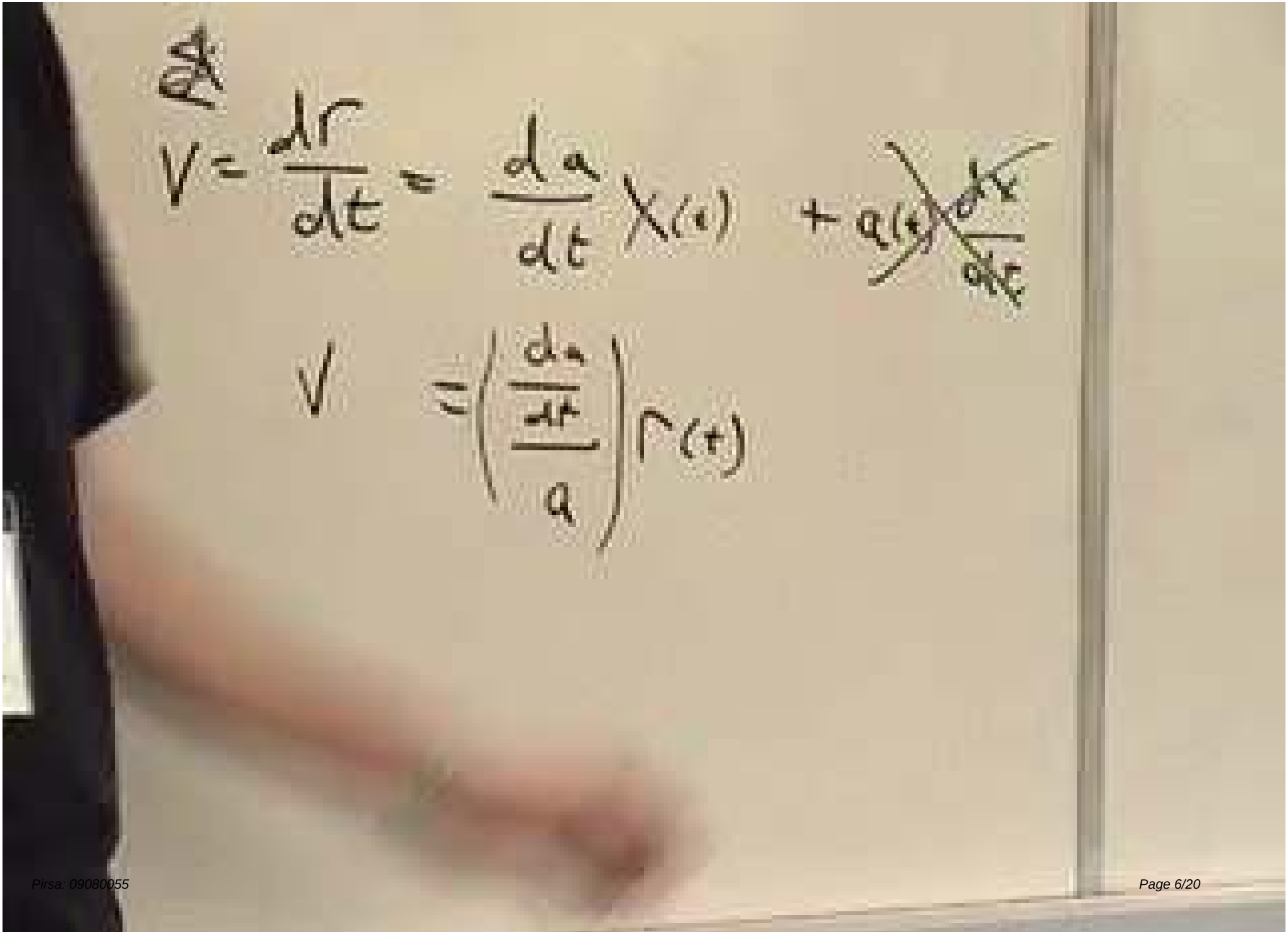
Abstract: The reason cosmologists have a job is that the Universe as a whole -- the stuff between planets and stars and galaxies -- is, despite first appearances, a pretty interesting place. The strangest fact about it is that it's expanding, and always has been, as far as we know (and though Einstein's theory of gravity predicts this, Albert himself didn't much care for the idea, at least at first). After about seventy years -- it was discovered in 1929 -- this expansion was kind of old hat, but then new observations came around that shattered the old complacency. The old idea was that the Universe was expanding, but slowing down as it went -- since gravity, as far as anyone knew, could only cause attractive forces. What the new observations demonstrated is that the Universe's expansion is, in fact, accelerating -- getting faster with time. This is so shocking that most astronomers and cosmologists couldn't believe it at first, and some still don't. In this talk, I'll explain a bit about how we know this, why it's so shocking, and tell you something about the crazy ideas people at Perimeter have for what's going on.

Welcome Mark Wyman

Talk title: What is the weight of nothing?


Vacuum
that state
that has no
excitations

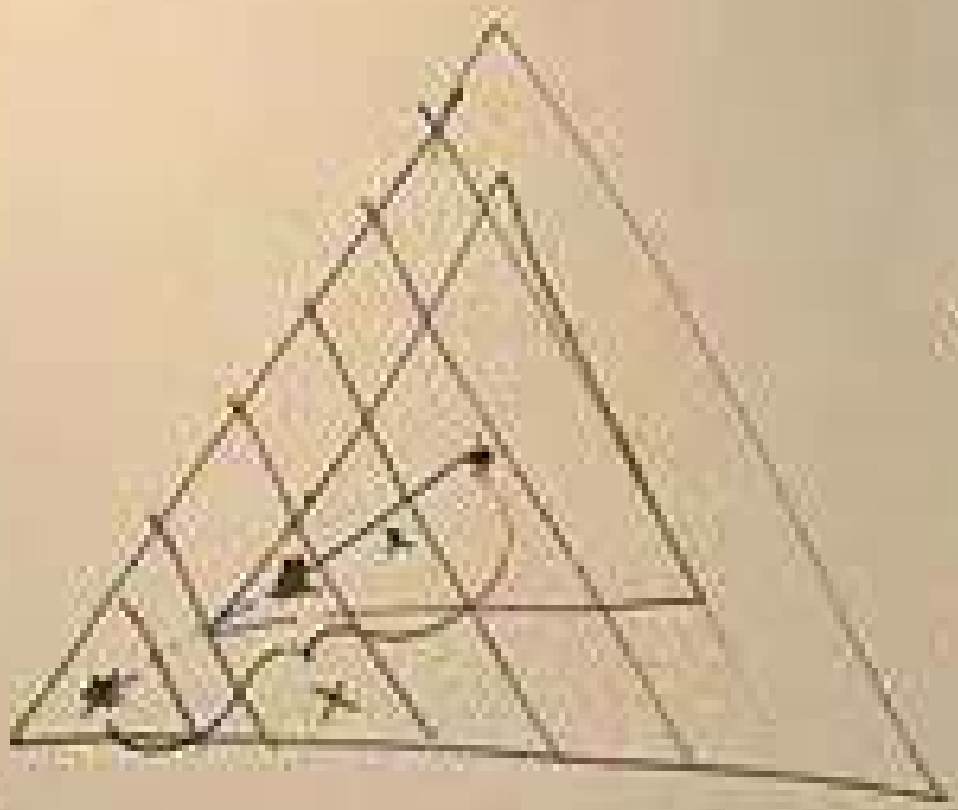

V = dΦ/dt
d/dt (f g)
Γ⃗Φ = q v⃗ x⃗(ω)


$V = \frac{dr}{dt} = \frac{da}{dt} r(t) + a(t) \frac{dr}{dt}$
$V = \left(\frac{da}{dt} \right) r(t)$

$$V = \frac{dr}{dt} = \frac{da}{dt} r(t) + a(t) \frac{dr}{dt}$$

$$V = \left(\frac{\frac{da}{dt}}{a} \right) r(t)$$

Hubble's Law



$$V = \frac{d\vec{r}}{dt} \qquad \lambda = \frac{T}{a}$$

$$\frac{d}{dt}(\quad) =$$

$$\vec{r}(t) = a\,\vec{x}(\omega t)$$

$$V = \frac{d\vec{r}}{dt} = \frac{d}{dt}\,x(\quad) + a(\quad)$$

$$V = \left(\frac{\frac{d\omega}{dt}}{a}\right) r(\quad)$$

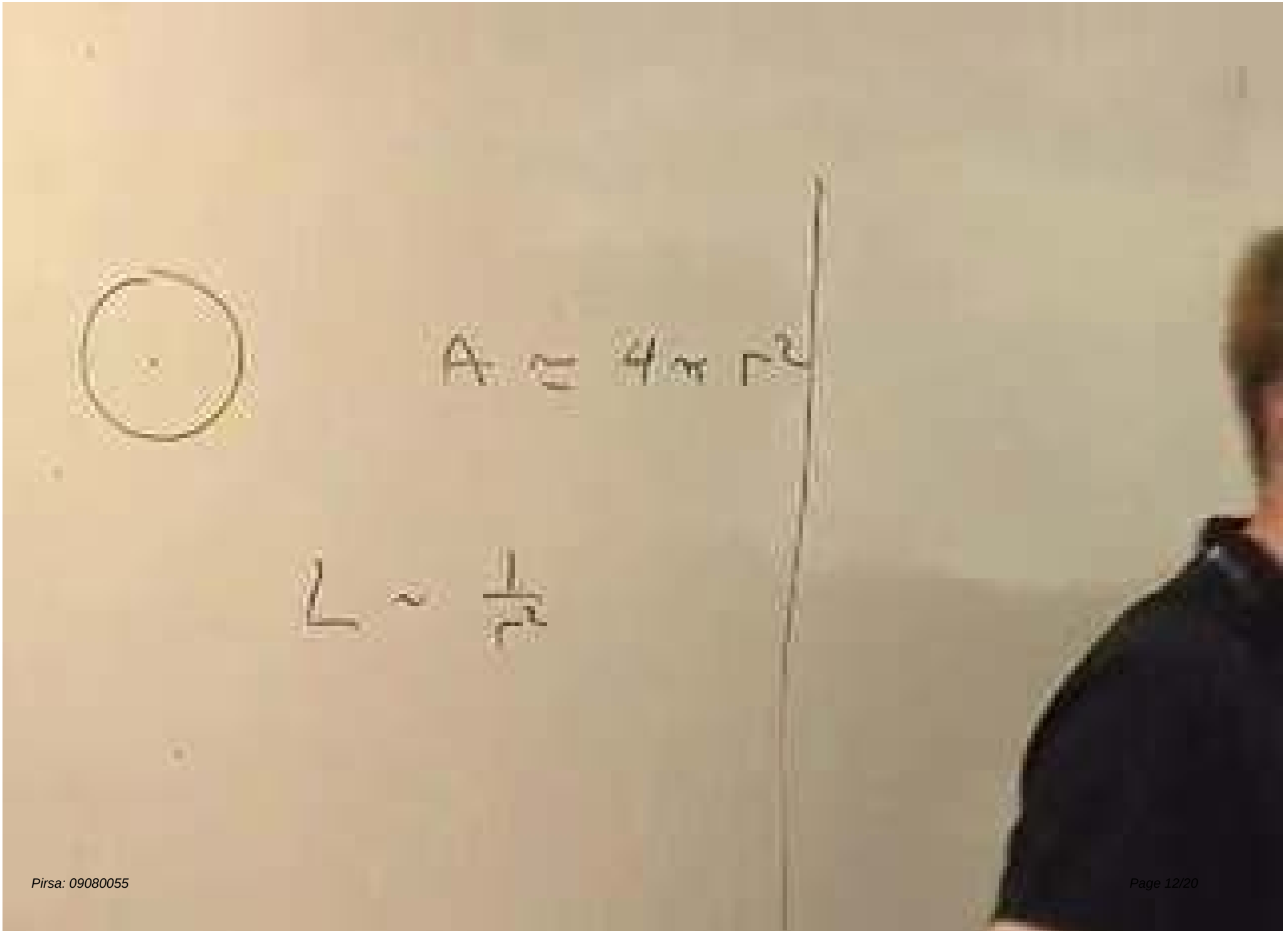
a = scale factor

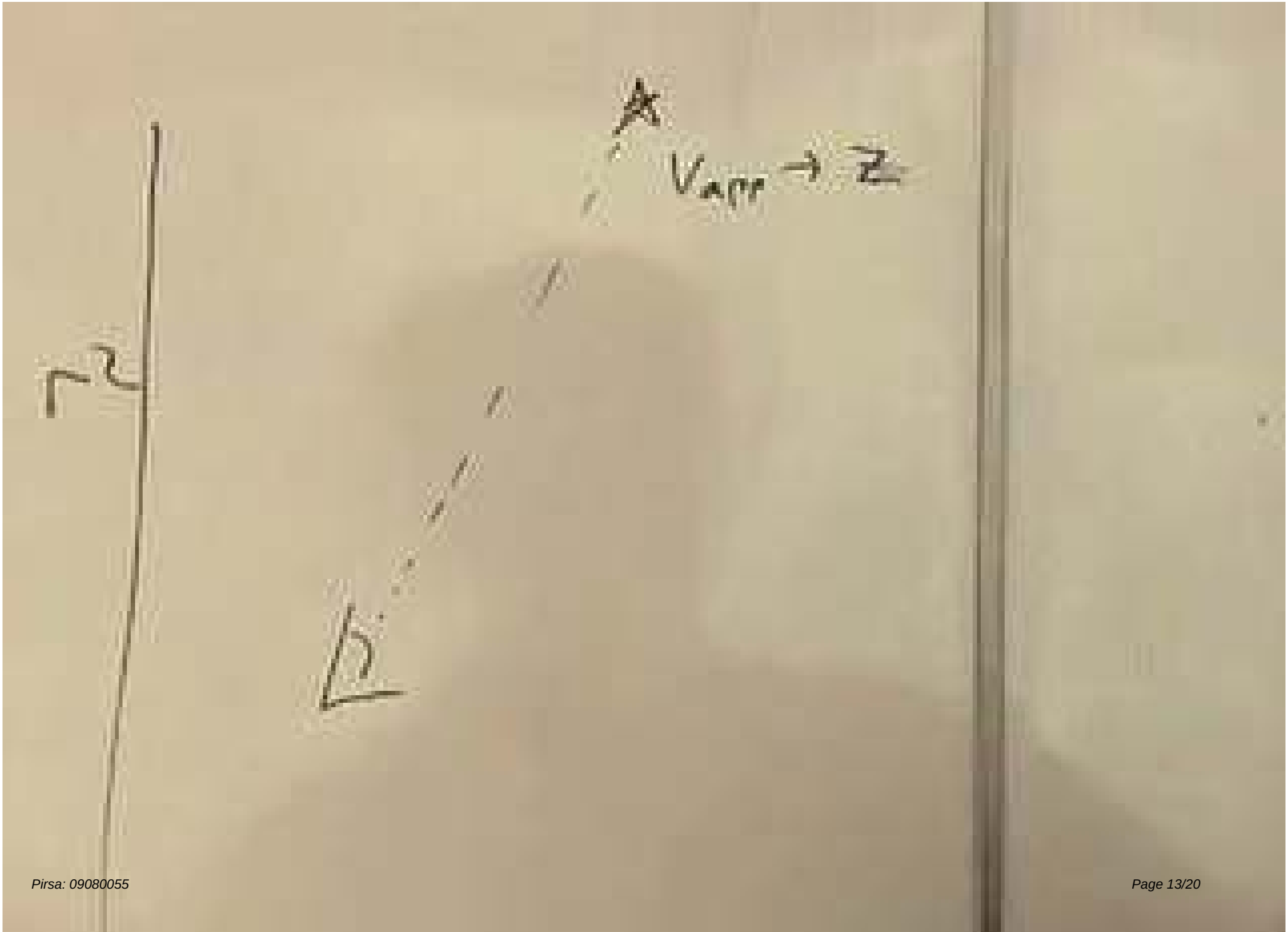
$$\frac{d\phi}{dr}$$

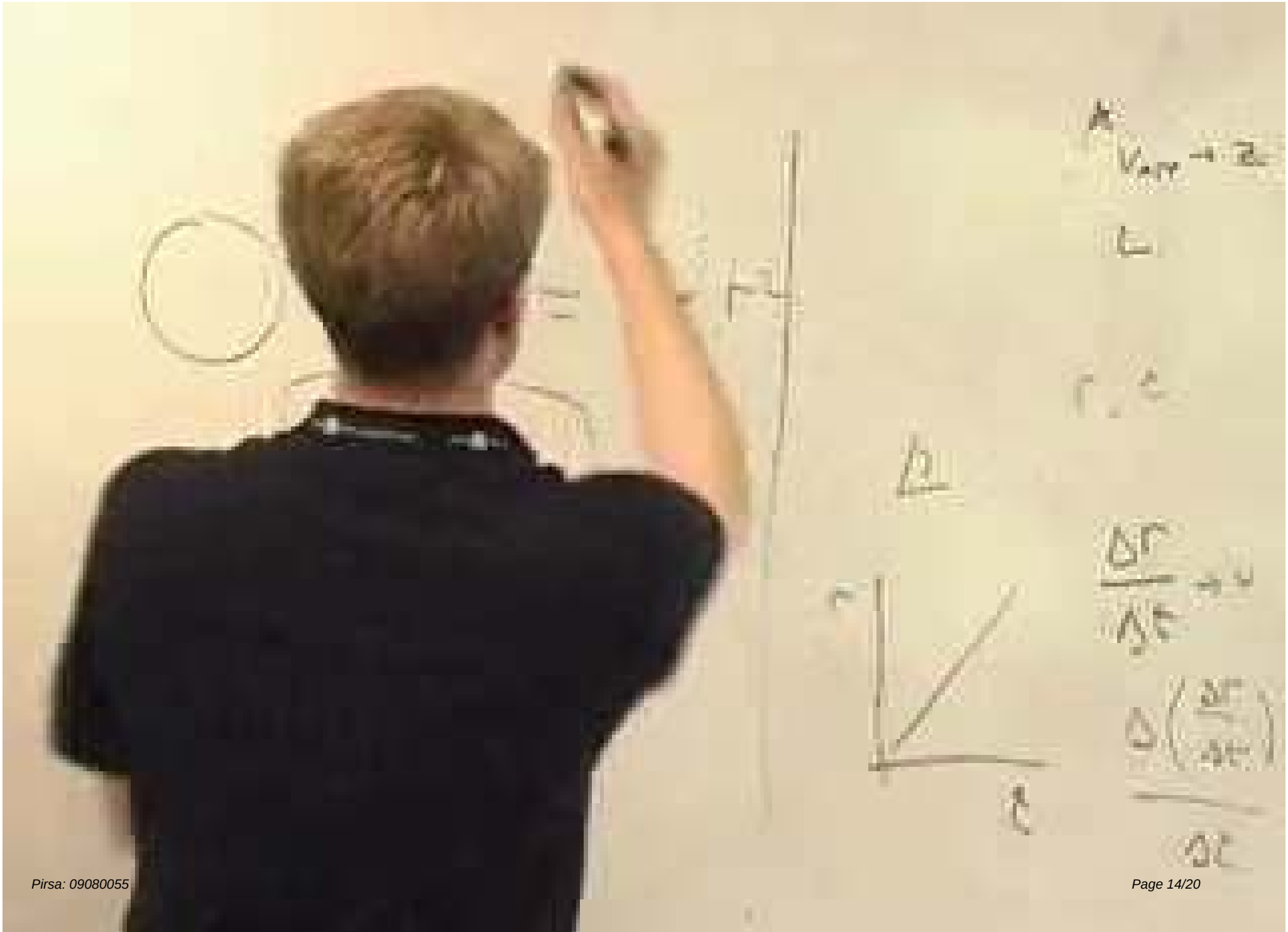
$$x = \frac{r}{a}$$

$$\frac{d\dot{a}}{dt^2}$$


density
pressure


$A \simeq 4\pi r^2$
$L \sim \frac{1}{r^2}$


$V_{eff} \to \infty$

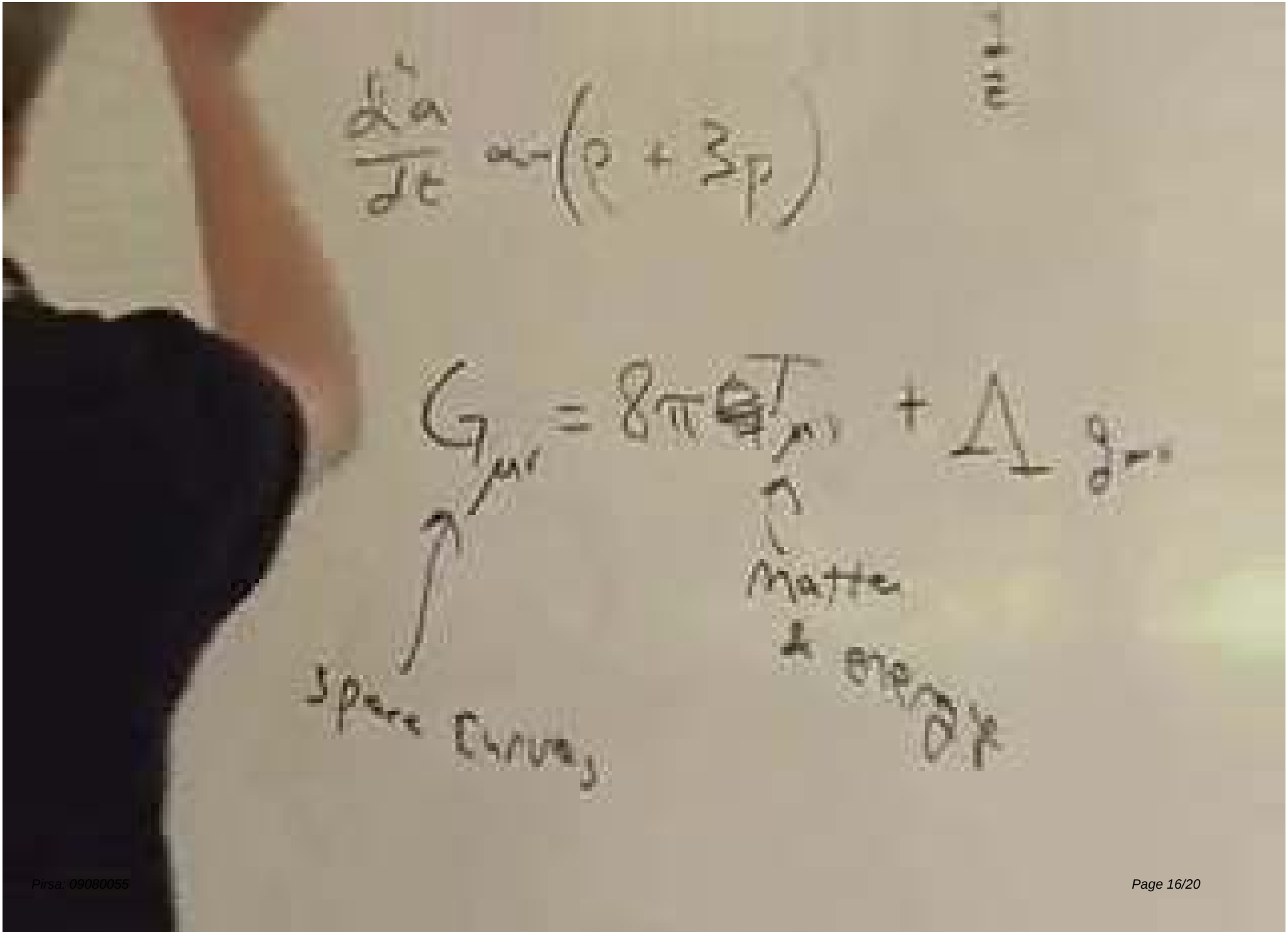


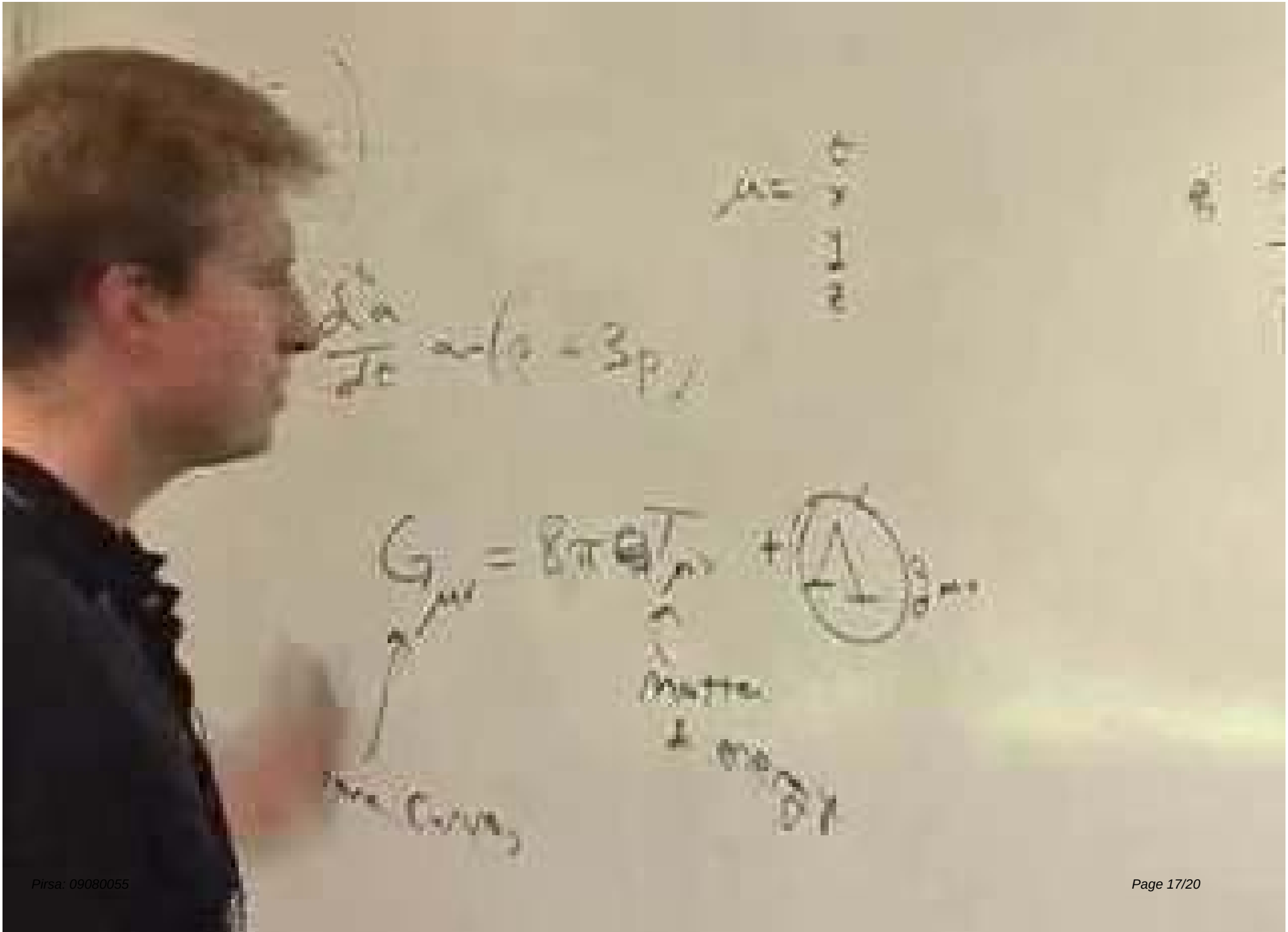
Astronomy Night

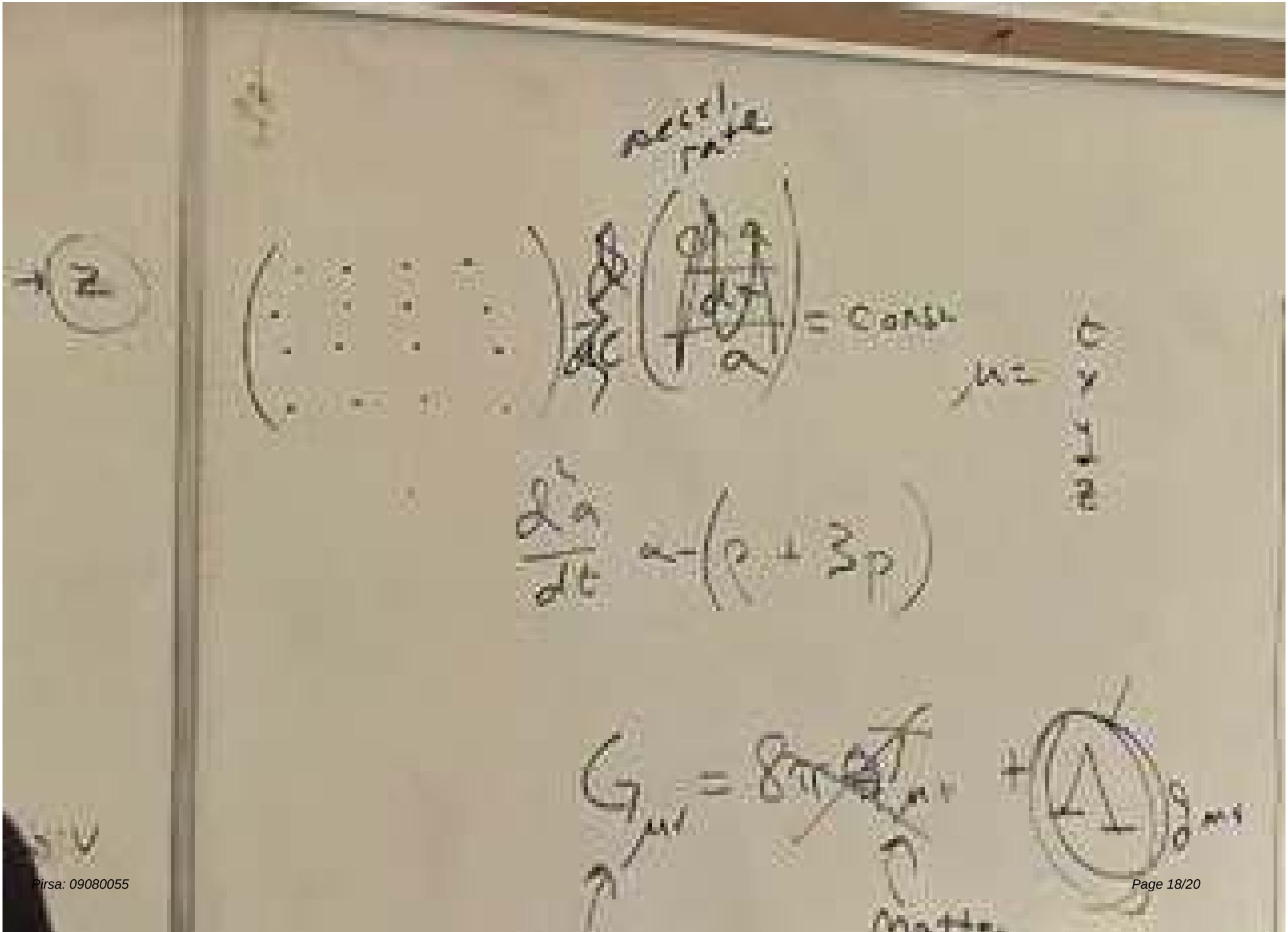
$P_{string} = -\frac{1}{3}\rho$

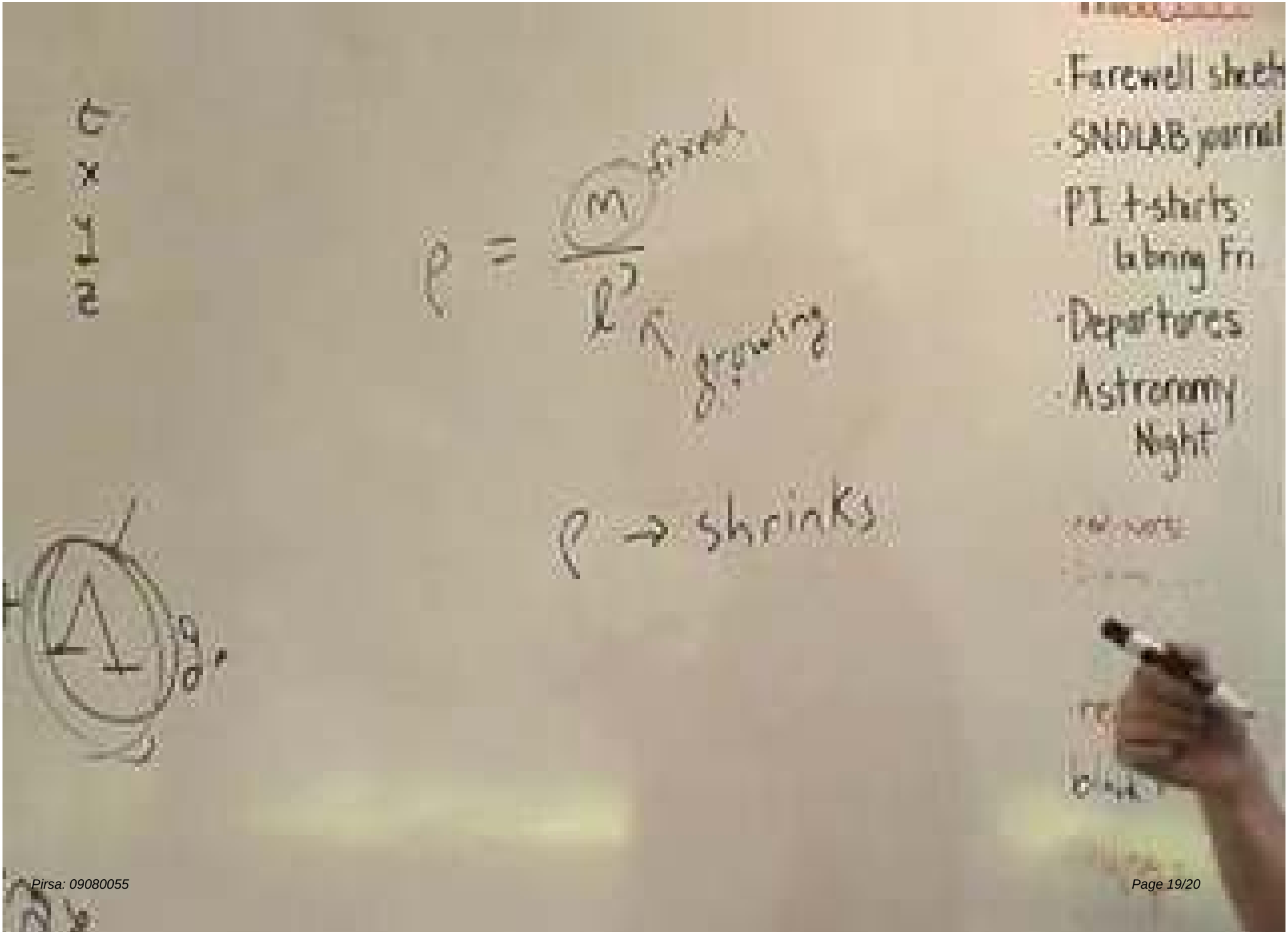
$P_{sheet} = -\frac{1}{2}\rho$

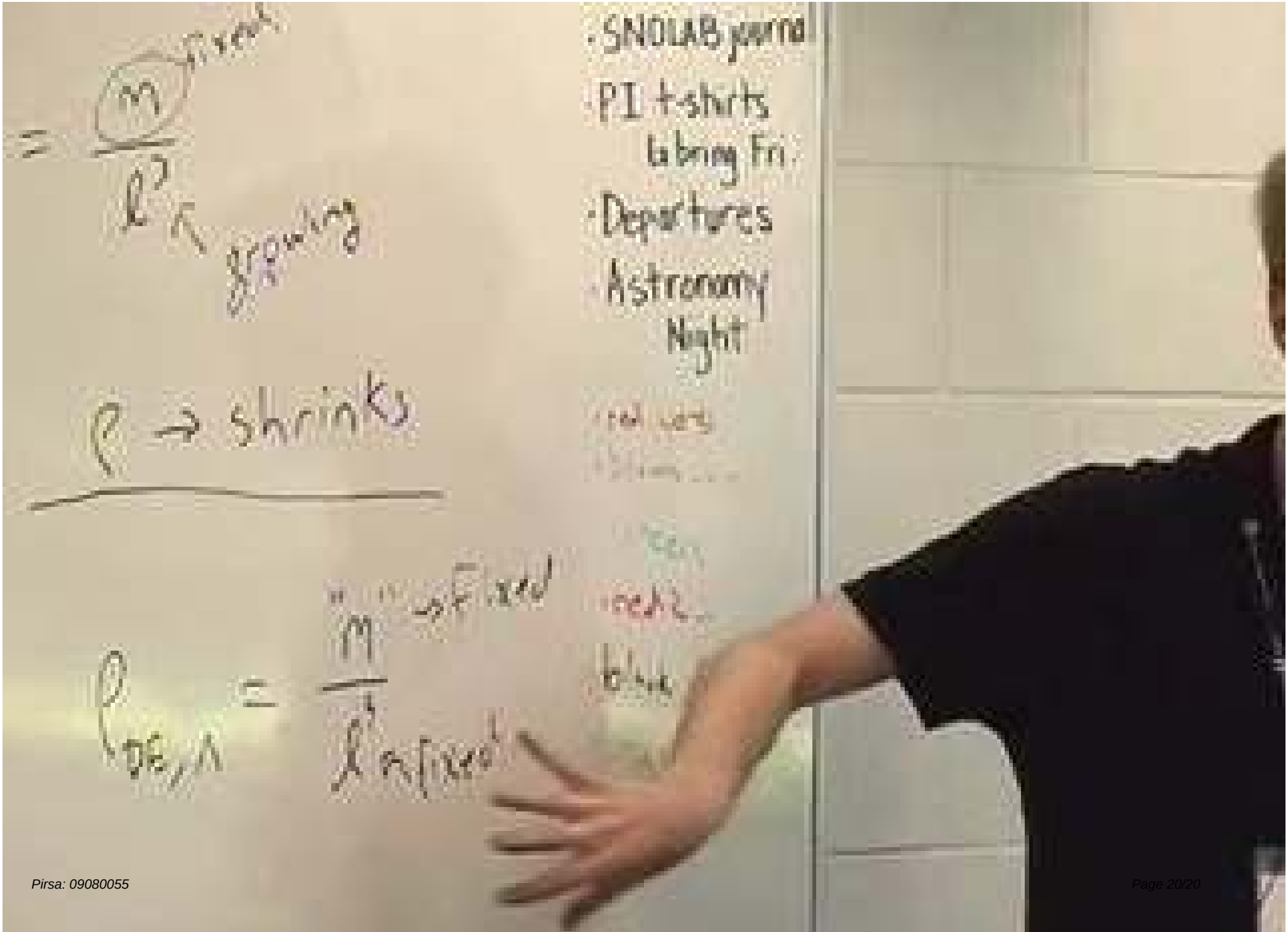
$P_{space} = -\rho$


$\frac{d^2a}{dt^2} \propto -(\rho + 3p)$
$G_{\mu\nu} = 8\pi G T_{\mu\nu} + \Lambda g_{\mu\nu}$
space curves
matter & energy


$G_{\mu\nu} = 8\pi G T_{\mu\nu} + \Lambda g_{\mu\nu}$
matter
Λ




Farewell sheet
SNOLAB journal
PI t-shirts
Departures
Astronomy Night


· SNOLAB journal
· PI t-shirts
to bring Fri.
· Departures
· Astronomy
Night