1.99 Motivation Summary

1. Laws of physics are the same in every reference frame; therefore equations describing laws of physics need to be invariant (i.e. have the same form) under any arbitrary coordinates. The old $F = ma$ fails this criteria, as it does not hold in accelerating reference frames.

2. When describing the path of a particle with parametric equations, time is a coordinate variable, not a parameter. Paths of particles are in spacetime instead of space.

3. Spacetime tells matter how to move; matter tells spacetime how to curve.

4. When there are gravitational sources (like black holes), spacetime is itself intrinsically curved, and only curved coordinates can be used. When there are no gravitational sources, spacetime is itself flat, and we can use either flat coordinates or curved coordinates.