In Newton mechanics it is accepted that time \( t \) is the same for all inertial coordinate systems, i.e. it is an absolute one. Contrary to this assumption, the Einstein’s principle of relativity is based on the fundamental idea that each inertial coordinate system \((XYZ)_k\) corresponding to the given particle or body is characterized with its own time \( t_k \). Other important consequences from the principle of relativity, such as a constancy of the velocity \( C \) of the light, dependencies of \( M_k \) and \( t_k \) values from the velocity \( V_k \) etc. are discussed in almost all courses of physics (e.g.[1]).

On the other hand, one can observe—at least in the framework of our Universe—that almost all particles and nuclei loose their masses through the radioactive decay. Due to different astrophysical processes most of astronomical objects—such as stars, planets etc.—also change their masses during their ”life”. Based on these widely spread natural phenomena one can formulate the following problem: would it be correct to assume that the flow of time \( dt \) depends from the change of mass \( \frac{dM}{M} \)? Can one establish a relationship similar to the law of radioactive decay and apply it to all particles and bodies? Does it mean that the following relationship

\[
\frac{dM}{M} = -\mu dt
\]  

satisfies the principle of relativity and now each particle, or nucleus, or body is characterized with its own time? The answer is positive, because time \( t \) is flowing until the mass \( M \) exists and \( \frac{\Delta M}{M} \neq 0 \). However, if \( \frac{\Delta M}{M} \rightarrow 0 \), the concept of \( t \) becomes meaningless. Unfortunately, one cannot say anything about the unknown parameter \( \mu \). It is not clear whether \( \mu \) is a function of coordinates \((XYZ)\), velocity \( V \), mass \( M \), electrical charge \( Z \), etc. Although one does not know the physical meaning of that parameter, one can try to extract the most simple consequences from eq.(1). Also, one can make some numerical evaluations of \( \mu \), which will allow to get better understanding of problems associated with proposed connection between \( M \) and \( T \).

The time interval \( \Delta t = t_2(M_2) - t_1(M_1) \) between two events is defined as

\[
\Delta t = -\mu^{-1}ln\left(\frac{M_2}{M_1}\right)
\]  

(2)

One should note that the value of \( \Delta t \) changes its sign to the opposite if \( M_2 > M_2 \). Eq.(2) has also an exponential form:

\[
\frac{M_2}{M_1} = exp(-\mu \Delta t)
\]  

(3)

If \( \mu \Delta t \rightarrow 0 \), then \( M_1 = M_2 \). Having \( \mu \Delta t < 1 \), one can use a simple relationship

\[
\Delta t = \mu^{-1} \frac{\Delta M}{M}
\]  

(4)

Eq.(4) establishes that the flow of time \( t \) depends from both the relative change of mass \( \frac{\Delta M}{M} \) and the parameter of \( \mu \).
The velocity $V$ of particles and bodies can be found from the following equation:

$$V = -\mu \Delta S \left( \frac{\Delta M}{M} \right)^{-1} \quad (5)$$

Here $\Delta S$ is a distance. It is interesting to note that if $\frac{\Delta M}{M} \to 0$, the flow of time becomes infinitely slow and thus $V \to \infty$. However, if $\frac{\Delta M}{M} \to 1$ the velocity $V$ reaches a certain value, which depends from the parameter $\mu$. To satisfy the principle of relativity one should assume that always $V < C$. It happens if $\frac{\Delta M}{M} \neq 0$ and if $\mu < \frac{\Delta M}{M} C (\Delta S)^{-1}$.

The energy $E$ of a body with mass $M$ and velocity $V$ always has a positive sign:

$$E = \left( \frac{\mu^2}{2} \right) M (\Delta S)^2 \left( \frac{\Delta M}{M} \right)^{-2} \quad (6)$$

Let us consider several bodies with different $M_k$, $(\Delta M_k/M_k)$, $V_k$ and $\mu_k$, that are situated at different distances $\Delta S_k$ from the point they simultaneously meet each other. It can happen if

$$\frac{\Delta S_1}{V_1} = \frac{\Delta S_2}{V_2} = \ldots = \frac{\Delta S_k}{V_k} \quad (7)$$

These ratios can be simplified:

$$\frac{1}{\mu_1} \frac{\Delta M_1}{M_1} = \frac{1}{\mu_2} \frac{\Delta M_2}{M_2} = \ldots = \frac{1}{\mu_k} \frac{\Delta M_k}{M_k} \quad (8)$$

Thus, only moving bodies satisfying the eq.(8) can cause events that happen simultaneously in a given point of space.

An attempt to estimate unknown parameters $\mu$ and to try to understand their meaning is described below. In the case of decay of nuclei and elementary particles a simple way of estimation of $\mu_n$ is proposed. By using the eqn.(4) and well known relationship $\Delta t \Delta E \geq \left( \frac{h}{2\pi} \right)$ one can reach the following equation:

$$\mu_n = \left( \frac{h}{2\pi} \right)^{-1} \Delta E \frac{\Delta M}{M} \quad (9)$$

Assuming that $\Delta E \approx 1 MeV$ and that $\frac{\Delta M}{M} \approx 1$ one gets an estimation of $\mu_n \approx 10^{23} sec^{-1}$. The value of $V = C$ is reached at the distance $\Delta S$ of about $3.10^{-13} cm$. Estimated values of $\mu_n$ and $\Delta S$ are in agreement with accepted values for a nuclear time of $10^{-23} sec$ and a nuclear length of $10^{-13} cm$.

A $\beta$-decay of neutrons is a process with week interaction between the products of the decay. Assuming that $\frac{\Delta M}{M} \approx 10^{-3}$ and $\Delta t \approx 10^3 sec$, one gets a value of $\mu_w \approx 10^{-6} sec^{-1}$. Most of $\beta$-radioactive nuclei with masses around $A = 100$ and half-lives of about $10^{-2} - 10^2 sec$ are characterized with values of $\frac{\Delta M}{M} \approx 10^{-5}$ and values of $\Delta t \approx 10^{-2} - 10^2 sec$. Therefore, one gets values of $\mu_w \approx 10^{-3} - 10^{-7} sec^{-1}$. There is no contradiction between this interval of values and the value of $\mu_w \approx 10^{-6} sec^{-1}$ for $\beta$-decay of neutrons.
However, it is much more difficult to estimate the parameter $\mu_g$ for astronomical objects, which interact with gravitational fields of other bodies. Assuming that a hypothetical body has a mass $M \approx 6.10^{27} g$, a half-life $\Delta t$ of $\approx 3.(10^{16} - 10^{17}) sec$, that is close to the age of Universe and $\frac{\Delta M}{M} \approx 0.3.(10^{-16} - 10^{-17})$, one can get a rough estimation for $\mu_g$, which is of $\approx (10^{-33} - 10^{-35}) sec^{-1}$. It is curious the normalized to $\mu_n$ values of $\mu_n$, $\mu_w$ and $\mu_g$ to be compared. One gets the following ratios: 1 : $(10^{-26} - 10^{-30}) : (10^{-56} - 10^{-58})$. These ratios have to be considered only as an illustration, since we ignored large $\beta$-decay half-lives of some nuclei that reach the value up to $10^{15}$ years. Besides that, one did not consider half-lives of astronomical bodies that are much shorter than the age of Universe.

Although, one does not know the physical meaning of these parameters, it is interesting to compare them with dimensionless constants $C_S$, $C_w$, and $C_G$ for strong, weak and gravitation interaction and their ratio: 1 : $10^{-24}$ : $10^{-46}$. Both $\mu$- and $C$-values are shown on Fig.1 in logarithmic scale and look quite similar.

As one should have expected, the proposed simple connection between $M$ and $t$ generates more problems than one could have discussed in this short letter. However, an attempt to propose a new and a quite natural "$M - t$" connection, which is described above seems to be not a meaningless one due to some important consequences.

References

1. L.D.Landau and E.M.Lifshitz "Course of Theoretical Physics", "Nauka", Moscow, 1968.

Caption to the figure 1.

Comparision between the $\mu$ and $C$-values for strong, weak and gravitational interactions.
Figure 1

Graph showing the relationship between $|\text{LgC}|$ and $|\text{Lg}_\mu|$ with interaction on the x-axis.