Is the rate of flow of "time" constant throughout the universe?

The flow of time is **NOT** constant for different observers in our universe. Two different observers can definitely observe that their clocks are not measuring the same rate of flow of time. Note that a single observer can never observe or experience different rates of flow of her own time since by definition she always experiences that 1 second takes exactly 1 second.

However, she could notice that some other person's clock only ticks off a half second (or two seconds) in the time her clock measures 1 second and thus that the rate of flow of the other observer's time is half (or twice) her rate of flow of time.

The easiest way to see this is for gravitational time dilation in the case of the Schwarzschild metric for a spherically symmetric non-rotating, non-charged object. Let's imagine that there is one observer who is at a very large distance (or "infinite" distance) from another observer who is sitting on the surface of the spherical object in question. We assume that neither observer is moving. So in this particular case the metric reduces to:

$$d\tau^2 = (1 - r_s/r)dt^2$$

where the Schwarzchild radius is:

$$r_s = 2GM/c^2$$

and where dt is the time interval measured by the first observer (at "infinity"), r is the radius of the sphere where the second observer is sitting and $d\tau$ is the proper time measured by the second observer.

From this we see that the ratio of the rate of time flow for the observer at infinity to the observer at r is:

$$dt/d\tau = 1/\sqrt{1 - r_s/r}$$

So as $r \longrightarrow r_s$ this ratio approaches infinity! So the deeper you are in a gravity well the slower your clock runs when compared to a clock at infinity and you and the observer at infinity will agree on this ratio!

Now the question details ask a lot of other questions. Here are the answers:

- So, is it possible to control its flow or at least affect it?

Yes. By going deeper in a gravity well, you can slow down your rate of time flow compared to a distant observer by as much as you want - but you have to get close to the Schwarzchild radius to get to large ratios of the rate of time flow - so it is not really practical to get big ratios.

- Is this hypothetical situation possible that somewhere in this universe, where there is life, the time passes at such a high rate that lives almost don't exist with respect to Earth; or at such a low rate that there is no intelligent species (due to evolution)?

On the surface of black holes, time does not flow from the point of view of distant observers. However note that you cannot stand on the surface of the black hole - you will inevitably fall into the black hole.

- How can we compare its flow at a particular place with respect to Earth?

Use very accurate clocks and transmit electromagnetic radiation from one observer to the other observer at fixed intervals and compare the received interval to the interval as measured on your clock.

- Can a space without time exist?

In general no, but on the surface of black holes time does appear to stop for distant observers.

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