Effect of Limited Stirring at Different Temperatures on the Belousov Zhabotinsky Reaction

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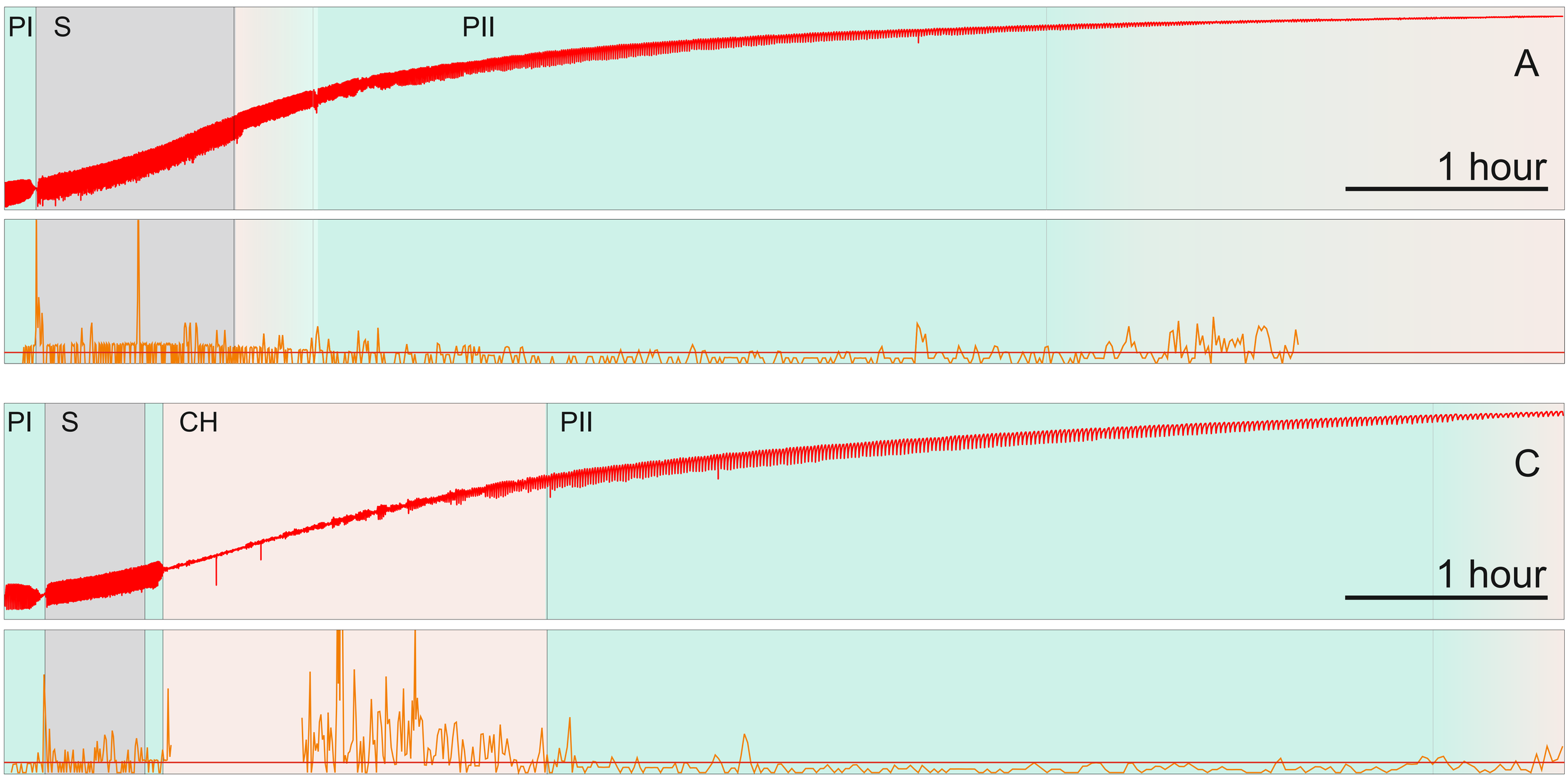

Figure 1: Effect of temperature on the periodic color change. In general there exist four distinct regions (phases): the first periodic phase (PI), the stirring phase (S) and a short periodic phase right after (PS), the aperiodic (chaotic) phase (CH) and the second periodic phase (PII)**. A and B:** Similar behavior at different temperatures and different stirring times; B: stirring time 120 min at 21°C (blue)., A: stirring time 60 min at 30°C (red). **C and D:** Similar behavior at different temperatures and different stirring times; D**:** stirring time 60 min at 21°C (blue)., C**:** stirring time 30 min at 30°C (red). Below every time series there is a plot of the relative variation of the period time as a function of time . This relative variation of the period time was used to analyse the periodicity of the signal i.e. to decide where the different phases start and end. Red line indicates the value 0.04 of the relative variation of the period time, which seams to be a threashold value deciding if the signal is periodic or not.

Abstract.

The effect of a limited stirring phase on the general behavior of the periodic color change in a closed Belousov Zhabotinsky (BZ) reaction was investigated systematically. In general the behavior of the system after stirring is more 'complex' if the temperature is lower.

Discussion

In general the color change in an unstirred and closed BZ reaction system goes through different stages (phases) before it 'dies out' after approx. 10 hours. After a short (approx. 20 min) periodic (initial) phase it evolves into an aperiodic (chaotic) phase which last for approx. 1 hour. This phase is followed by a second periodic phase which last up to 8 hours. We found that the effect of stirring on the BZ reaction has other consequences too apart from the pure homogenization of the system. A limited stirring phase can result in a shortening or the complete disappearance of the aperiodic phase mentioned above which is present in the non-stirred case.

We also discovered that the temperature has an effect on this behaviour other then the well-known increase in oscillation frequency. If the temperature is ‚high' (30°C) the time needed to get similar results as at ‚low' (20°C) temperature is half of the time as in the ‚low' temperature case.

This can be seen as a kind of self-similarity which is not absolutly perfect since the behaviour at ‚low' temperature is more ‚complex' then at high temperatures (compare the relative variation of the period time at different temperatures).

Acknowledgments

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[1] **F. Wodlei, M. R. Hristea**: *Effect of Limited Stirring on the Belousov Zhabotinsky Reaction*. CSS Archive, *to appear* (or *http://www.ilsr.at/material_methods.pdf*)