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On the bifurcations inducing the 40-to-100 kyr transition of the Pliocene/Pleistocene glacial cycles

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Using a specially designed wavelet-transform technique I demonstrate a nonlinear and bifurcational nature of the famous 40-to-100 kyr transition of the Pleistocene glacial cycles. It can be depicted as a result of combined actions of two factors. The first factor is a general climate system cooling during the whole Pliocene/Pleistocene time period essentially accelerated after the Panama seaway closure about 4000 kyr BP. The second factor is the quasiperiodic oscillations of insolation at the Milankovitch orbital frequencies. The response of the climate system to the 41-kyr-periodic insolation forcing was stable during the warm Pliocene times, and so the climate variations consisted of a ~40-kyr limit cycle. As a result of the climate system cooling this limit cycle lost its stability, and a new climatic limit cycle of the doubled period and larger amplitude has been excited about 1250-1500 kyr BP because of a resonance of this new-born cycle with insolation forcing at the combinational tone of the eccentricity variations $1/82=1/95-1/1307+1/413$. Some more climate cooling implied the loss of stability this doubled cycle too, and instead, the next climatic limit cycle of the trebled period has been excited because of the another resonance with insolation forcing at the combinational tone of the eccentricity variations $1/123=1/95-1/413$.

Key Words: Paleoclimate, Milankovitch theory, insolation forcing, glacial cycles, bifurcations, resonances