Study of Modal Patterns and Dynamic Emission Characteristics in Pulsar B1822-09

The research presented here examines an 8-hour observation of pulsar B1822-09, taken by the Giant Metrewave Radio Telescope. B1822-09 has been known to exhibit two stable emission modes, the B-mode, where the precursor (PC) "turns on", and the Q-mode, which is defined by interpulse (IP) emission. These emission modes are like pulsar "personalities." The results of our analysis, of this extremely long observation, have shown that B1822-09 exhibits a number of "personalities" that have not been seen before in other similar pulsars or in other observations of B1822-09. We have observed at least 3 new "personalities" of B1822-09, which include: Q-mode emission occurring intermittently within B-mode emission sequences, B-mode emission occurring intermittently within Q-mode emission sequences, and both emission modes are "on" when transitioning from one mode to the other.

Further investigations have shown that this pulsar seems to exhibit periodicities in its emission that have not been seen before. Previous studies have shown a periodicity at $42.3P_1$, while in our studies we have found periodicities at $41.8P_1$, $46.3P_1$, and $86.7P_1$. These periodicities help us define the geometrical structure of the emission of pulsars. Along with these new values for periodicities in B1822-09, we were able to discover intricate internal structures within the main pulse, interpulse, and precursor that have been hypothesized but not proven, until now. Our new results on this unique pulsar are giving us a better idea of how complicated the emission of pulsars can be, which will lead us to better empirical theories on pulsars, so that we can finally discover their secrets.