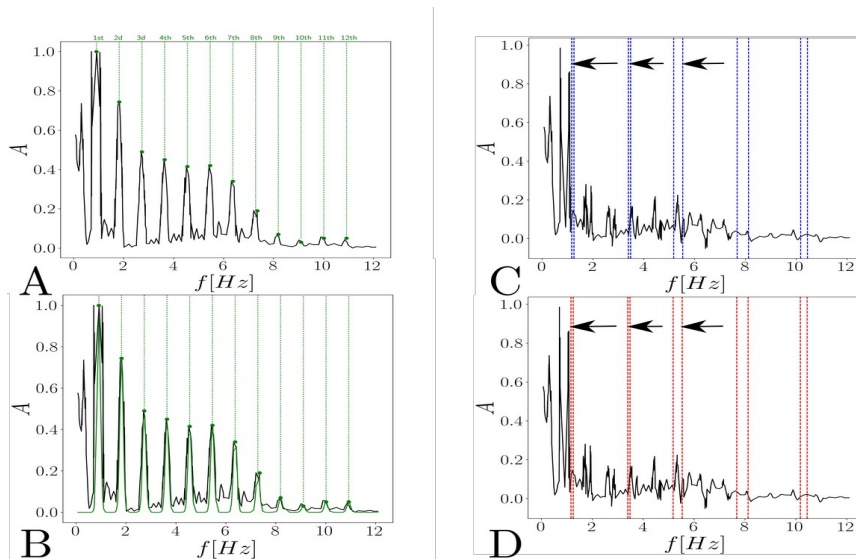


# REVEALING THE VASCULAR SIGNATURE OF INTRA-CRANIAL PRESSURE

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This work discusses a new signal analysis approach permitting to decipher the vascular signature of intra-cranial pressure which can be applied to various high-frequency dynamical signals (typically up to 100 Hz) of intra-cerebral pressure from various methods such as optic nerve sonography or transcranial Doppler. A detailed mechanical model for the pulse wave-propagation within the complex cerebral vascular network of the Willis circle is build from a long-wavelength approximation of Fluid-Structure-Interaction (FSI) pressure pulsed waves waves. Long-wavelength FSI-waves continuity condition within networks are derived. The resulting coupled wave system is solved within any network generalizing a recently proposed quantum-graph eigen-mode decomposition approach (Plouraboué, 2024). The spectral condition associated with the secular matrix evaluation is derived, providing the intrinsic pulsating modes of arterial pulse waves. The theory is applied to the circle of Willis arterial network for which the spectrum is explicitly computed and compared with clinical observations related to the intra-cranial pressure dynamics. Retrieving the cardiac frequency modes from the observed pulse signal produce consistent results between the new modes predictions and observations. This leads to a new understanding of intra-cranial pressure frequency content, related to pressure pulse propagation within the arterial network, containing relevant clinical information about the arterial's physiological and mechanical response.



*Retrieving cardiac's signature of (A-B) out of cerebral pressure  
Fourier Spectrum shows intrinsic vascular frequencies predicted  
by our approach (C-D).*

F.Plouraboué, [Quantum graph waves external triggering : energy transfer and damping](#), *Phys. Rev. E.*, **109**, 5, 054310, 2024.

F Plouraboué, [Revealing the vascular signature of intra-cranial pressure dynamics](#), *npj Biological Physics and Mechanics*, **2**, 23, (2025).