Mathematical Concept of the Bloch Flow Equations for General Magnetic Resonance Imaging: A Review

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ABSTRACT: The recent analytical solutions to the Bloch NMR equations for a general RF excitation have opened many possibilities for further investigations to NMR theory and experiments even at the molecular level. Fortunately, many of the most important but hidden applications of blood flow and general physiological fluid flow parameters can be revealed without too much difficulty if appropriate mathematical techniques are used to explore the new NMR equations derived from the Bloch equations. Generally, we should be very much concerned with analytical results that the Bloch NMR flow equations can provide for different physical, biomedical, geophysical, medical, and environmental situations especially at the molecular level for the purpose of interdisciplinary approach to solve difficult problems. It can be motivating, exciting, and rewarding if attention are focused on the possible application of these analytical techniques and methods suitable for describing each of the various normal and pathological biological conditions. Most solutions presented in this study are described both in isotropic and anisotropic geometries with minimum mathematical assumptions. We discussed a general expression for the diffusion coefficients in the common geometries. These analytical results can prove to be very invaluable in the analysis of restricted flows. It is so much special because it could tell us when restricted flows occur and also reveal the causes of such restriction. Such knowledge can help in finding the causes of many diseases (whose causes are yet unknown) and suggest the best treatment for them. Concepts Magn Reson Part A 38A: 85–101, 2011.

KEY WORDS: Bloch NMR flow equations; diffusion coefficient; NMR diffusion equation; magnetic resonance imaging (MRI)

Received 1 September 2010; revised 9 March 2011; accepted 18 March 2011

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Concepts in Magnetic Resonance Part A, Vol. 38A(3) 85–101 (2011)
Published online in Wiley Online Library (wileyonlinelibrary.com).
DOI 10.1002/cmr.a.20210