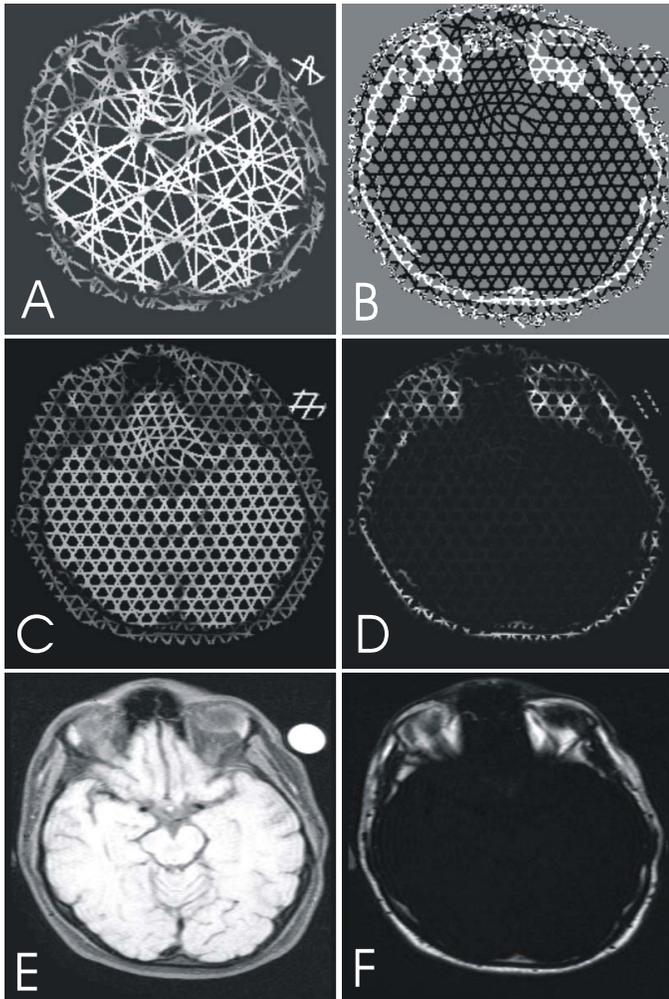


# Water-Fat Imaging by Direct Phase Encoding with Solution Along Isophasic Lines (SAIL)

Q-S. Xiang<sup>1</sup>

<sup>1</sup>Department of Radiology, University of British Columbia, Vancouver, BC, Canada

**Introduction** Water-Fat Imaging (WFI) has gained much popularity in recent years although the basic idea was proposed as early as 1984 [1]. Most early approaches used symmetric sampling that acquired data only when water and fat magnetization vectors are at parallel and anti-parallel [1,2]. Asymmetric sampling, which acquires data at other angles between the two vectors, was a crucial step for both separation and identification of water and fat unambiguously [3,4]. With 3-point acquisitions, asymmetric sampling allowed pixel-level Direct Phase Encoding (DPE) [3] without having to use error prone phase-unwrapping, leading to more robust results. For WFI, simple and efficient analytical solution [3] exists, although a more general numerical least-squares solution [5] can also be used [6]. DPE works well for pixels containing both water and fat. For pixels with only a single chemical component, further phase correction, such as region growing, is needed. This work describes a new approach to handle these pixels. Since it is more likely to have both water and fat in many pixels across the object, pixels with the same magnetic field inhomogeneity can be grouped together so that DPE and analytical solution can be used. In other words, WFI is achieved with Solution Along Isophasic Lines (SAIL).



**Methods** Data with (0,90,180) degree sampling were first corrected for baseline phase error that is extracted from the in-phase image. The opposed-phase image is then squared and smoothed in complex form. It is further traced along isophasic lines. All pixels along each isophasic line experience the same magnetic field inhomogeneity. They are grouped into a long “super pixel” for direct water-fat solution as they are unlikely to contain only a single chemical component. Each individual pixel along the line is subsequently resolved. Artificial phase errors can be imposed onto the object by applying phase gradients in various orientations to cover more pixels and to improve robustness.

**Results** Figure (A) is a water image obtained along coarse isophasic lines. (B), (C) (D) are respectively polarity map, water and fat images obtained by SAIL with finer isophasic lines in three orientations. (E) and (F) are final water and fat images, obtained by SAIL in more orientations so that all pixels are covered in the FOV. The results are satisfactory.

**Discussion** A new algorithm, termed SAIL, for water-fat imaging is described. Pixels along isophasic lines are grouped together for a direct solution, since these pixels share the same magnetic field inhomogeneity and are likely to contain both water and fat. SAIL is more straightforward and robust than some early approaches.

## References

- [1] WT Dixon, Radiology, 153, 189-194, 1984
- [2] GH Glover, JMRI, 1, 521-530, 1991
- [3] QS Xiang and L An, JMRI, 7, 1002-1015, 1997
- [4] QS Xiang, MRM, 56, 572-584, 2006
- [5] L An and QS Xiang, MRM, 46, 126-130, 2001
- [6] SB Reeder et al, MRM, 51, 35-45, 2004