# Shell Trajectory Sampling of K-Space in Magnetic Resonance Imaging

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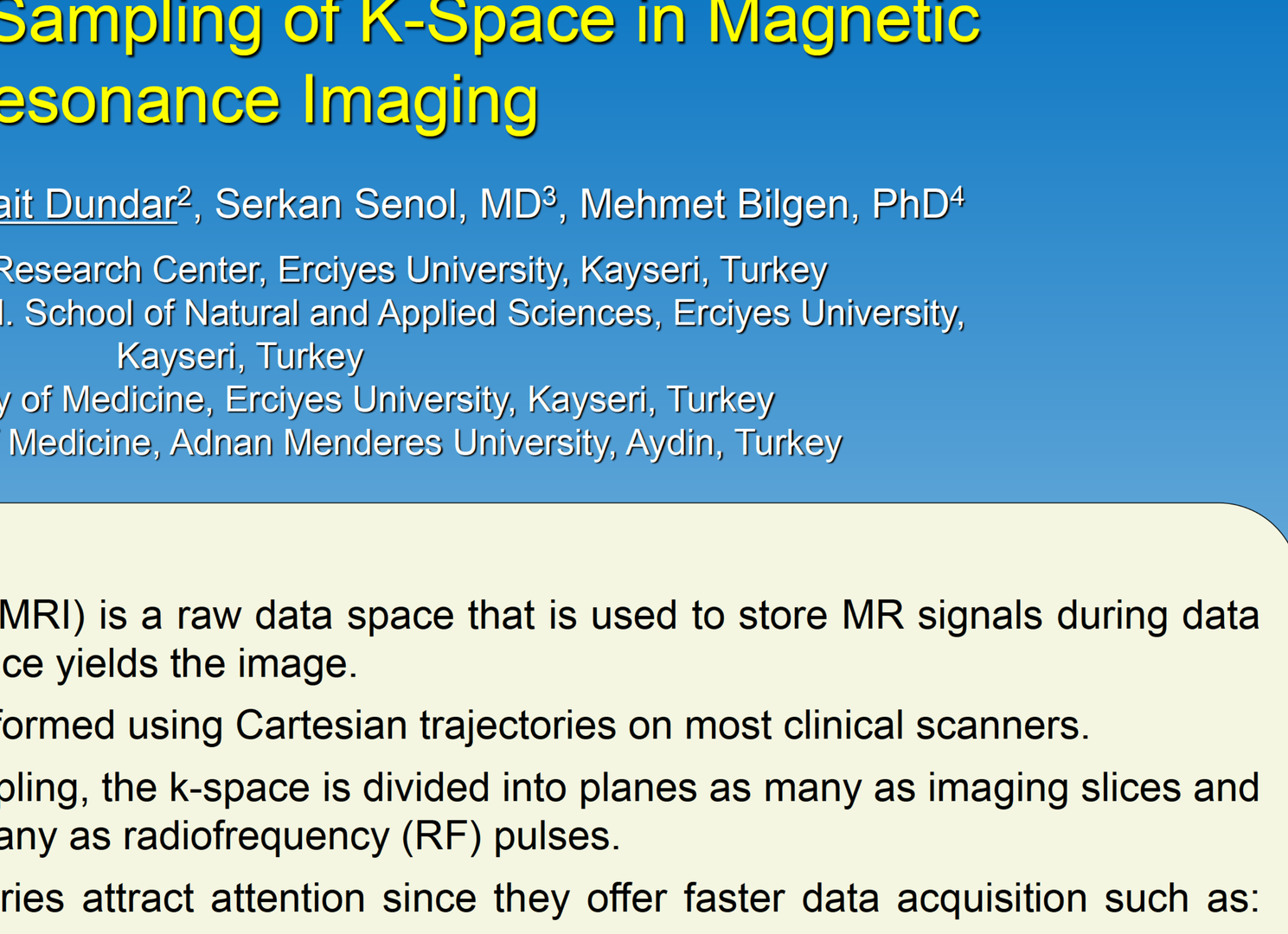
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## Introduction

- K-space in magnetic resonance imaging (MRI) is a raw data space that is used to store MR signals during data acquisition. Fourier Transform of the k-space yields the image.
- The sampling of k-space is commonly performed using Cartesian trajectories on most clinical scanners.
- In a standard 2D Cartesian trajectory sampling, the k-space is divided into planes as many as imaging slices and each k-space plane consists of rows as many as radiofrequency (RF) pulses.
- Recently non-Cartesian sampling trajectories attract attention since they offer faster data acquisition such as: 2D/3D stacks of spirals and 3D shells [1].

## Materials & Methods

- We developed 3D concentric shell (ConShell) sampling trajectories in MATLAB.
- We calculated the necessary gradients to implement during MR acquisition.
- We did the theoretical comparison of the ConShell sampling with 3D Cartesian sampling (Fig.a).




## Results

- An example of 3 concentric shells in Fig.b and the corresponding gradients (Gx, Gy, Gz) in Fig.c to implement on MR scanner.
- For the following MR parameters: FOV=256mm x 256mm x 256mm, Resolution 4mm x 4mm x 4mm,
- Cartesian sampling employs $64^2$ RF pulses, corresponding to 64 partitions and 64 rows in each partition.
- ConShell sampling utilizes only 64 RF pulses using 64 shells.

## Conclusions & Discussion

- ConShell sampling of k-space allows reduced number of RF pulses and the efficient use of gradients.
- ConShell sampling accelerates image acquisition. Without any under-sampling, several-fold increased speed compared to 3D Cartesian acquisitions.
- Limitation of ConShell sampling: it requires special image reconstruction such as re-gridding before Fourier Transform.
- The future study is to acquire MR images using the ConShell sampling and develop it for Diffusion MRI using under-sampling strategies.

## References

[1] Zahneisen et al., 2011, Magn Reson Med, 68(2), 484-494.

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