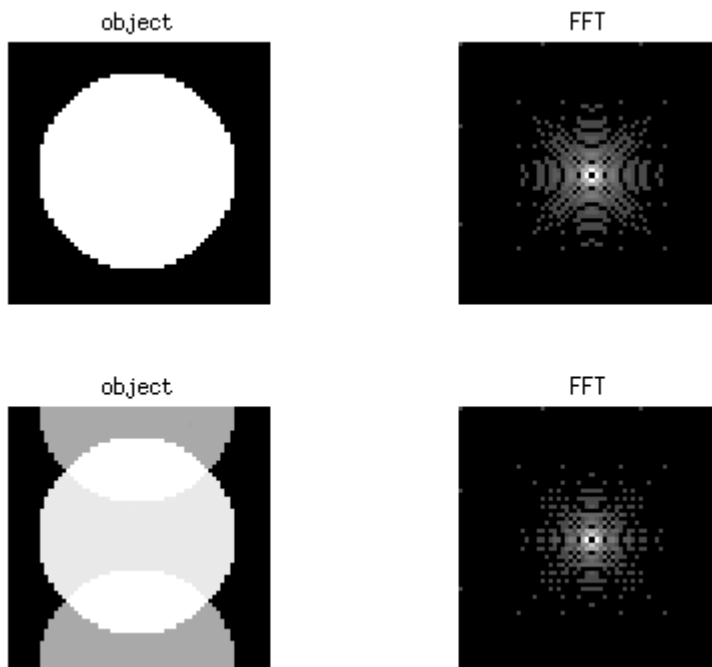


**HW5: Answer Key**

1) Describe what is different about the k-space (FFT) for the top (good) image vs. the bottom (ghosted) image.

The k-space for the bottom image with the ghosting has a strong every-other-line modulation (which in a typical EPI pulse sequence would come from an imbalance in the integral of the read-out gradients with opposite polarity).



2A) Why is the chemical shift artifact in the 3rd EPI image (the one with low res / low BW) not as bad as the chemical shift artifact in the 1st EPI image (high res / low BW)?

The two images have the same bandwidth, but the high-resolution image takes four times as long to read out the data (with the same BW, each read-out line takes twice as long to acquire, and there are twice as many read-out lines to acquire to get the high resolution in the PE direction). [Note that, while the total read-out time is 4X longer, the severity of the shift is only increased by 2X. This is because our calculation of displacement is in Hz/pixel, and the high-resolution pixels are half as big as the pixels in the low-res image.]

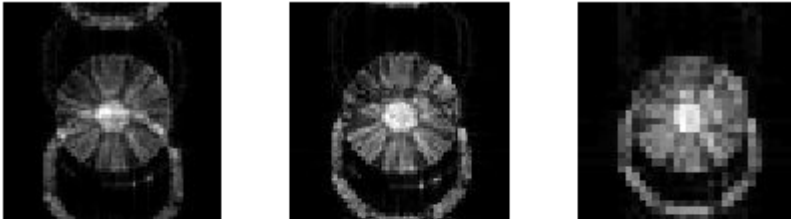
2B) Describe, in your own words, why chemical shift artifacts (and other off-resonance effects) go in a different direction for the FLASH image than for the EPI image-1?

FLASH is impervious to off-resonance effects in the PE direction because every PE line gets the same treatment; EPI is most sensitive to off-resonance effects in the PE direction because it takes (in these simulations) 32 or 64 times longer to collect information in the PE direction.

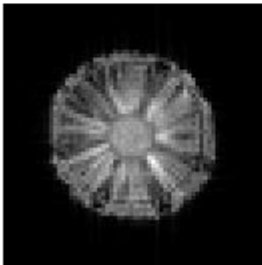
2C) Describe, in your own words, why EPI images are more susceptible to off-resonance effects than FLASH images.

The echo time is typically 10X longer, and the total amount of time the magnetization spends down on the transverse plane (without the "reset" of another excitation pulse) is typically 50-100X longer.

EPI, high res / low BW    EPI, high res / high BW    EPI, low res / low BW



FLASH, high res / high BW



FLASH, high res / low BW

