Figure 1

a) Proton exchange between pool s (agent) and pool w (water) with exchange rates $k_{sw}$ and $k_{ws}$.

b) Saturation pulse affecting the water peak amplitude.

c) Water peak amplitude decreases after saturation.

d) Enhanced signal in Z-spectrum or CEST effect and direct saturation or spill-over effect. 

$\Delta \omega_{sw}$ saturation-frequency offset
Figure 2

a.  

b.  

c.  

d.  

e.
Figure 3

The figure illustrates the timescales of different processes:

- **Macroscopic diffusion**
- **Chemical exchange**
- **Molecular rotations**
- **Molecular vibrations**

The timescales are represented as follows:

- Slow: s, ms, μs
- Fast: ns, ps, fs

The distinction is made between relaxation timescales, spectral timescales, and larmor timescales.
Figure 4

The figure shows a graph with frequency offset (ppm) on the x-axis and M/M₀ on the y-axis. The graph illustrates the effects of APT and Direct water NOE effect on M/M₀. The red arrow indicates the location of the APT effect, while the green curve represents the Direct water NOE effect.
Figure 5

(a) $P_A = \frac{K_{WS}}{K_{SW} + K_{WS}}$  \quad $P_B = \frac{K_{SW}}{K_{SW} + K_{WS}}$

(b) $P_A = 75\%$  \quad $P_B = 25\%$

- **Slow exchange**  
  $K_{SW} \ll \Delta\omega$

- **Intermediate exchange**  
  $K_{SW} \approx \Delta\omega$

- **Fast exchange**  
  $K_{SW} \gg \Delta\omega$

$\Delta\omega = 100\text{ Hz} = 100\text{ /sec}$
Figure 6

Pool s

M_{os}
R_{1s}

Pool w

M_{ow}
R_{1w}

k_{sw}
k_{ws}
Figure 7
Figure 8

a) RF preparation, EPI acquisition

b) Magnetic field directions and angles
Figure 11

a) 180° Water Suppression
    Mixed (Tm) Water Excitation
    WATERGATE pulse
    90° 90° 90° 90°

b) 180° Water Suppression
    Mixed (Tm) Water Suppression
    WATERGATE pulse
    90° 90° 90° 90°
Figure 12

a) Saturation

RF

G2

Gp

Gr

\[ \frac{\pi}{2} \]

\[ \Delta/2 + TE/2 \]

\[ \pi \]

\[ \Delta/2 + TE/2 \]

b) Saturation

RF

G2

Gp

Gr

\[ \frac{\pi}{2} \]

\[ e \]

\[ \frac{2\pi}{3} \]

\[ 2e + \Delta/2 + TE/2 \]

\[ \Delta/2 + TE/2 \]

c) Saturation

RF

G2

Gp

Gr

\[ \frac{\pi}{2} \]

\[ e/2 \]

\[ e/2 \]

\[ \Delta/2n \]

\[ \Delta/2n \]

\[ \Delta \]

\[ TE/2 \]

\[ \pi \]

\[ TE/2 \]
Figure 13
Figure 19

(a) $P^+$

(b) $P^-$

(c) $P_1^-$

(d) $P_2^-$

(e) $P^+ - P^-$

(f) $P^+ - P^-$

(g) $P^+ - P^-$

(h) $P^+ - P^-$

Frequency Offset (Hz)
Figure 20

Frequency offsets [ppm]
Figure 21
Figure 23
Figure 26

a) Radiative 90° CESt saturation pulse small flip angle (β)

b) a)

adiabatic 90°

CESt saturation pulse

small flip angle (β)

Radiative 90° delay small flip angle (β)

Slice loop

Ny lines

TR

Radiative 90°

CESt saturation pulse

small flip angle (β)

Radiative 90° delay small flip angle (β)

Slice loop

Ny lines

TR
Figure 27
Figure 29

RF

\[ \theta \]

Irradiation pulse

Excitation pulse

\[ 90^\circ \]

Acq.

Spoil Gradient
Figure 31

a) 
RF($\omega_+\_+')$

b) 
RF(SAFARI)

c) 
RF($\omega_0\_+')$

d) 
RF(SAFARI')

Crusher Gradient

$\frac{\text{TR}_{\text{ref}}}{\text{TR}_{\text{ref}}}$

$3s$

[EPi acq]
Figure 34