Model-Checking w Simulations
AND
Down-sampling and High-frequency error

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Simulating fits to Experimental Data

• For each path, we fit $\alpha$, $D$, and a linear drift velocity, $\mu_x$ and $\mu_y$, in each coordinate, respectively, using fbmMLE.m

• Using these parameters, we can simulate an experimental dataset, path-by-path, and compare MSD statistics of the experimental dataset to the simulated one(s) to validate our model fits

• Use fBmXY_HD.m to simulate the fBm component, inputting $\alpha$ and $D$ from fbmMLE.m, and the observation time and fps for the given experiment/path

• Use the “Beta” output of fbmMLE.m to simulate linear drift in each coordinate (more on next slide)
Simulating paths (cont.)

• If our experimental path has 1800 data points (30 seconds at 60fps, for example), we can simulate drift as follows:
  – driftx = [0:1799]’./60 * Beta(1);
  – drifty = [0:1799]’./60 * Beta(2);

• We then simply add these vectors to the x and y components of the fBm path output by fBmXY_HD.m to complete the simulation of a single path.
MSD(τ) in Water

- **Experimental MSD**
- **Simulated MSD**
fBm fits to Water

\[ \alpha \]

\[ D (\mu m^2 s^{-\alpha}) \]
High-Frequency Error

- It turns out that in some experimental data, there is an error found only in the highest frequencies (shortest lagtimes), that falsely increases the correlations between increments.
- We think this is due to dynamic tracking error in the camera.
- Our collaborators (Martin Lysy and Yun Ling) having created a model for this camera error and will have it incorporated in the MLE fits soon, but in the meantime…
Down-sampling

• By down-sampling the data, we can bypass the noise in the highest frequencies of the path data

• Do this by inputting every other point of the path data to fbmMLE, and inputting 2x the original frame rate; or every third point and inputting 3x the original frame rate. Looks like:
  – \( \text{mle} = \text{fbmMLE}(\text{path.Positions}(1:2:end, :], 2/60, 2/60) \) (if the frame rate of the camera is 1/60)
  – In general… \( \text{mle} = \text{fbmMLE}(\text{path.Positions}(1:i:end, :], i/60, i/60) \)