Numerical Verification: Deriving $\mathcal{E}(a) = e^{1-1/a}$ from Structure Formation
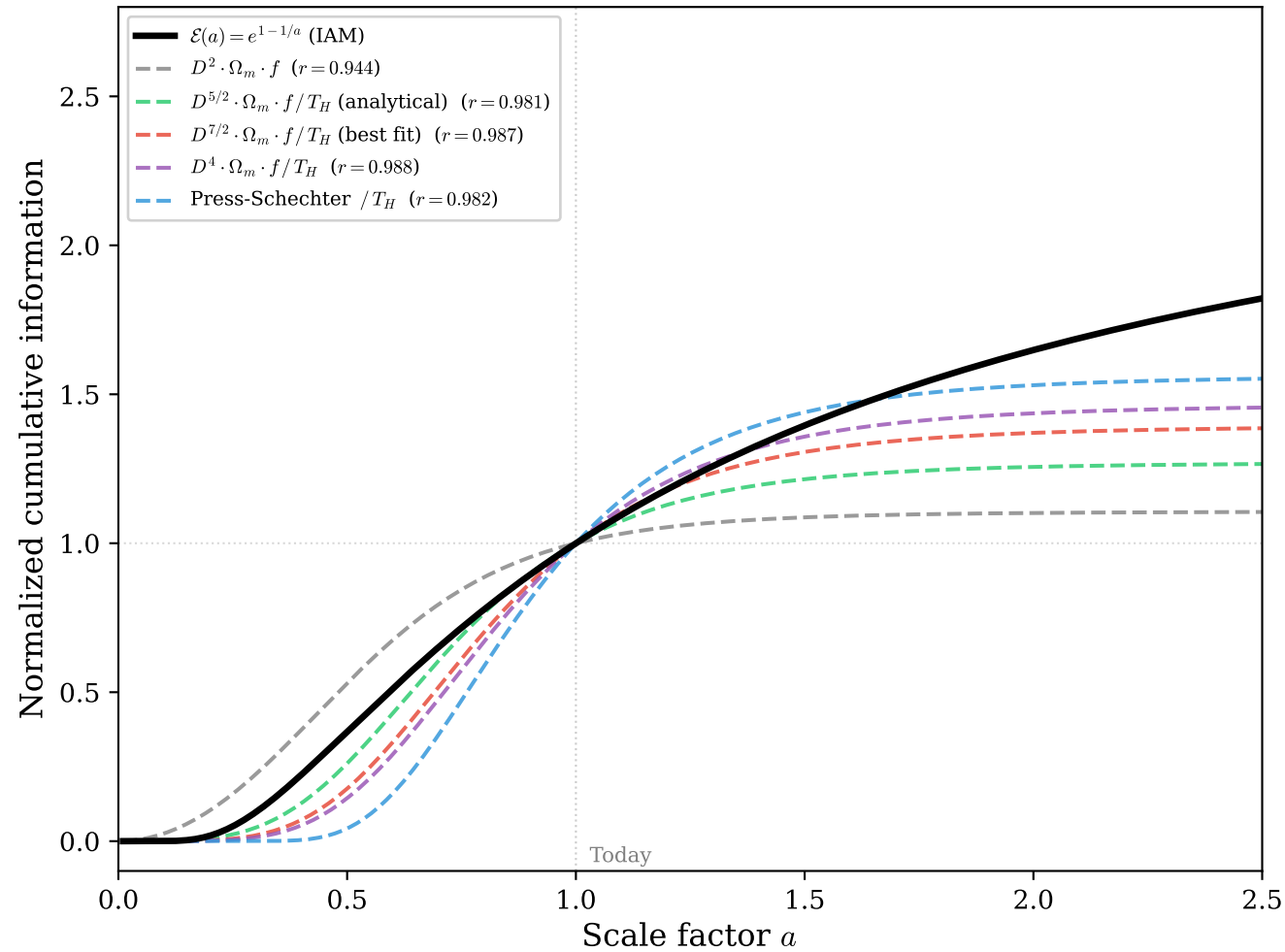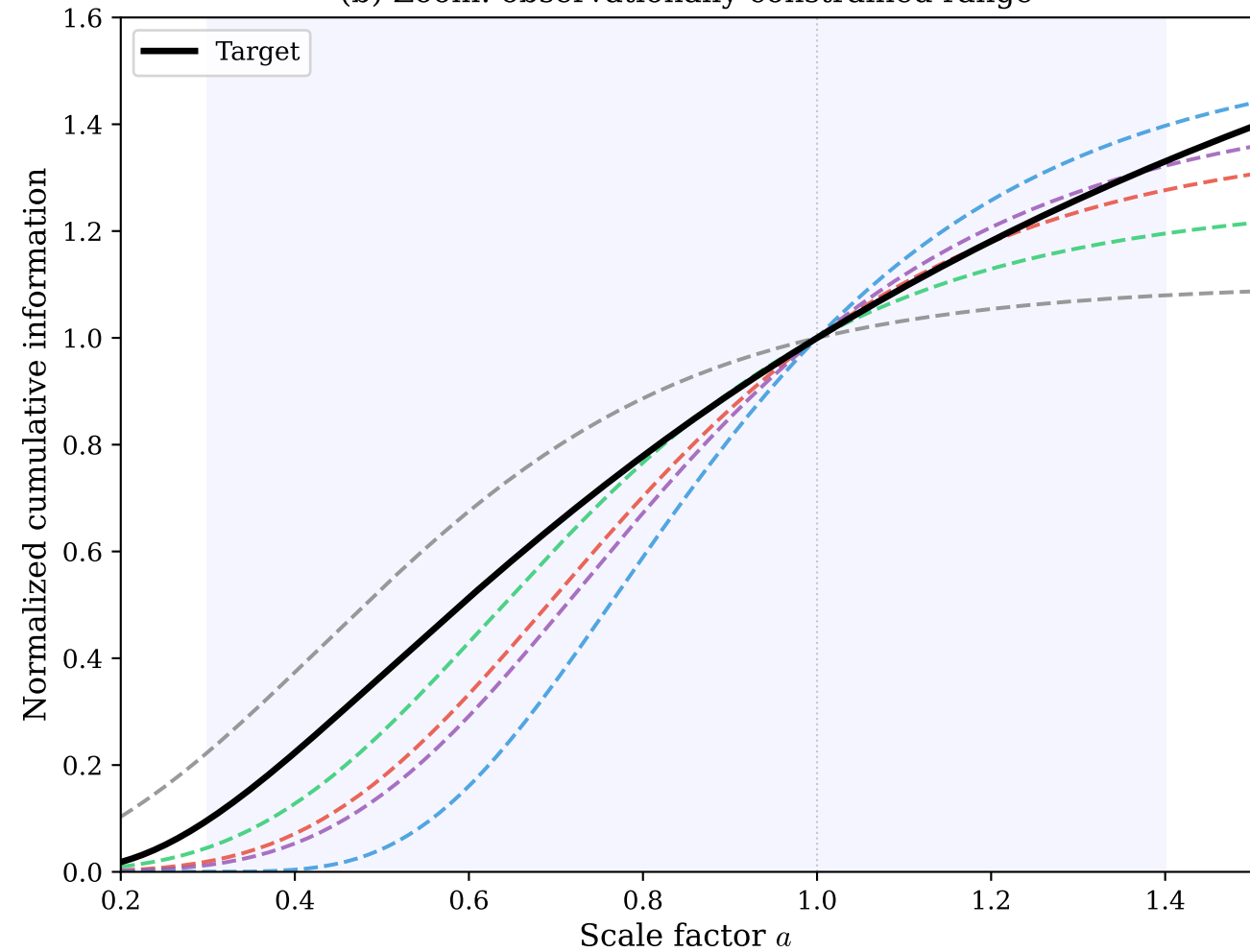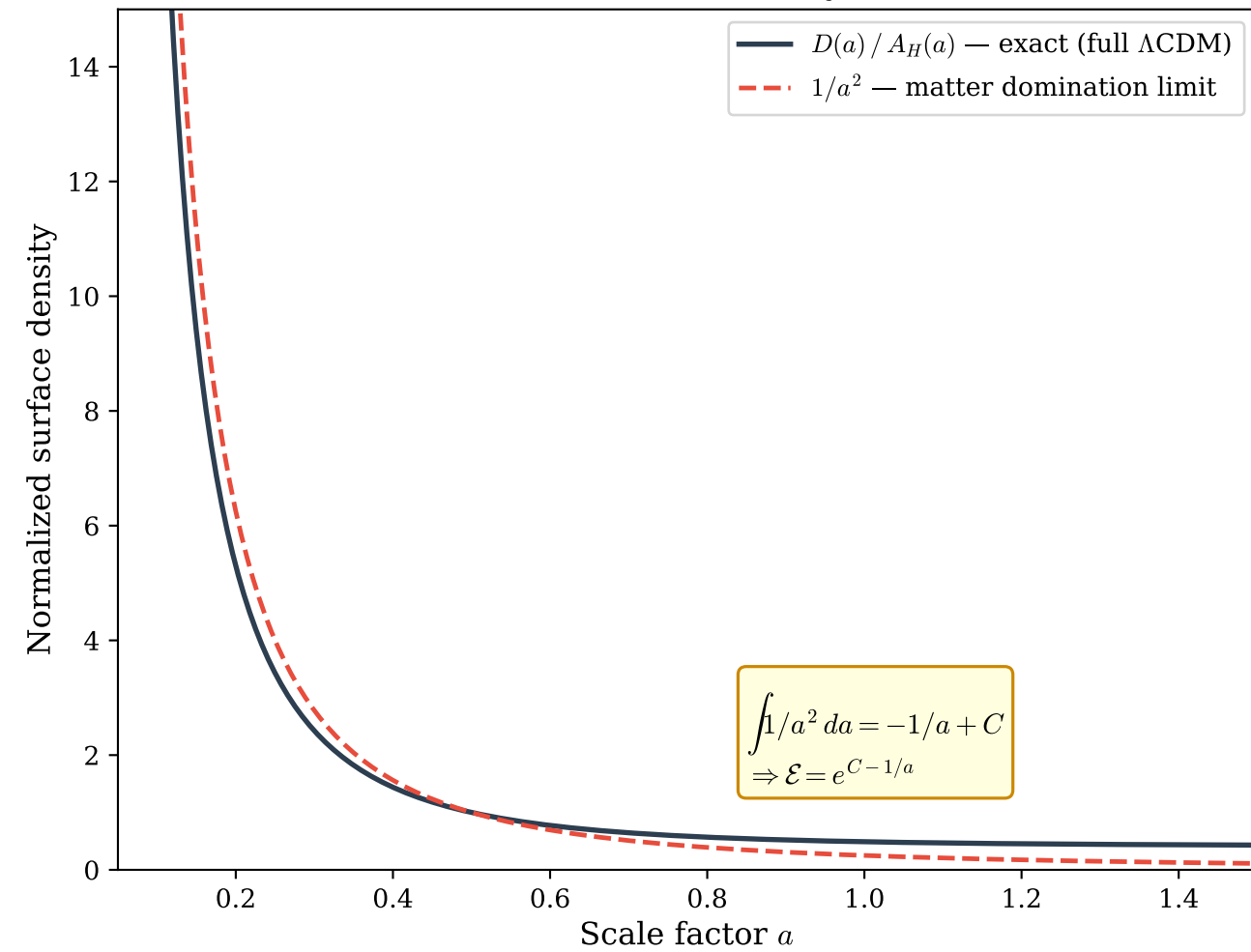

(a) Cumulative decoherence integral vs activation function

- $\mathcal{E}(a) = e^{1-1/a}$ (IAM)
- $D^2 \cdot \Omega_m \cdot f$ $(r = 0.944)$
- $D^{5/2} \cdot \Omega_m \cdot f / T_H$ (analytical) $(r = 0.981)$
- $D^{7/2} \cdot \Omega_m \cdot f / T_H$ (best fit) $(r = 0.987)$
- $D^4 \cdot \Omega_m \cdot f / T_H$ $(r = 0.988)$
- Press-Schechter $/ T_H$ $(r = 0.982)$

Normalized cumulative information vs Scale factor a. Today.

(b) Zoom: observationally constrained range

- Target

Normalized cumulative information vs Scale factor a.

(c) Information surface density on horizon

- $D(a) / A_H(a)$ — exact (full ΛCDM)
- $1/a^2$ — matter domination limit

$$\int 1/a^2 \, da = -1/a + C$$
$$\Rightarrow \mathcal{E} = e^{C - 1/a}$$

Normalized surface density vs Scale factor a.

(d) Exponential fit coefficients vs source nonlinearity

$\beta = 1$ at $n \approx 3.2$

$\alpha = 1$ at $n \approx 3.8$

Physical range

- α (fitted)
- β (fitted)
- $n = 5/2$ (analytical)

Fitted coefficient vs Nonlinear exponent n in D^n.