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Increasing the accuracy and temporal resolution of two-filter radon–222 measurements by correcting for the instrument response

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Equations (3)–(5) describe the evolution of radon progeny in an air parcel transitting the radon detector's delay chamber. Slug flow is assumed, meaning that there is no mixing between the air parcel and the surrounding environment. The concentration of radon progeny, N_A, N_B, and N_C is assumed to be zero when the air parcel enters the delay chamber at time $t = 0$.

With these initial conditions, the solution can be written analytically. We solved Eqs. (3)–(5) using the computer algebra system, Sage (http://www.sagemath.org). Because the solution is lengthy, it has been included here instead of writing it out in Sect. 2.2. The following snippet of python code expresses the solution at time t. Symbols in the paper are translated into variable names so that: $N_{\mathrm{Rn}} \rightarrow$ `Nrn`, $N_A \rightarrow$ `Na`, $N_B \rightarrow$ `Nb`, $\lambda_{\mathrm{Rn}} \rightarrow$ `lamrn`, $\lambda_A \rightarrow$ `lama`, $\lambda_B \rightarrow$ `lamb`, $\lambda_C \rightarrow$ `lamc`, and $\lambda_p \rightarrow$ `lamp`.

```
# exponential function
from math import exp

Na = Nrn*lamrn/(lama+lamp)-Nrn*lamrn*exp(-t*(lama+lamp))/(lama+lamp)

Nb = Nrn*lama*lamrn/(lama*lamb+lamp**2+lamp*(lama+lamb))-Nrn*lama*lamrn* \
     exp(-t*(lamb+lamp))/(lama*lamb-lamb**2+lamp*(lama-lamb))+Nrn*lama*  \
     lamrn*exp(-t*(lama+lamp))/(lama**2-lama*lamb+lamp*(lama-lamb))

Nc = Nrn*lama*lamb*lamrn/(lama*lamb*lamc+lamp**3+lamp**2*(lama+lamb+lamc)+ \
     lamp*(lama*lamb+lamc*(lama+lamb)))-Nrn*lama*lamb*lamrn*exp(-t*(lamc+  \
     lamp))/(lama*lamb*lamc+lamc**3-lamc**2*(lama+lamb)+lamp*(lama*lamb+   \
     lamc**2-lamc*(lama+lamb)))+Nrn*lama*lamb*lamrn*exp(-t*(lamb+lamp))/   \
     (lama*lamb**2-lamb**3-lamc*(lama*lamb-lamb**2)+lamp*(lama*lamb-       \
     lamb**2-lamc*(lama-lamb)))-Nrn*lama*lamb*lamrn*exp(-t*(lama+lamp))/   \
     (lama**3-lama**2*lamb-lamc*(lama**2-lama*lamb)+lamp*(lama**2-lama*lamb\
     -lamc*(lama-lamb)))
```

Further simplifications are possible, in particular by substituting the numerical values of the decay constants, $\lambda_A, \lambda_B, \lambda_C$ and λ_p.