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Functionalized AFM probes for force spectroscopy: eigenmodes shape and stiffness calibration through thermal noise measurements

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Supplementary data

Tables I to V report numerical values of \( \alpha_n(\tilde{m}, \tilde{r}) \), for the first 5 modes, \( 0 \leq \tilde{m} \leq 2 \) and \( 0 \leq \tilde{r} \leq 0.1 \).

**Mode 1: \( \alpha_1(\tilde{m}, \tilde{r}) \)**

| \( \tilde{m} \) | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 1.8751 | 1.8751 | 1.8751 | 1.8751 | 1.8751 | 1.8751 | 1.8751 | 1.8751 | 1.8751 | 1.8751 |
| 0.20 | 1.7227 | 1.7226 | 1.7225 | 1.7223 | 1.7221 | 1.7218 | 1.7215 | 1.7211 | 1.7207 | 1.7203 |
| 0.30 | 1.6164 | 1.6162 | 1.6161 | 1.6158 | 1.6155 | 1.6151 | 1.6146 | 1.6140 | 1.6134 | 1.6127 |
| 0.40 | 1.5361 | 1.5360 | 1.5357 | 1.5354 | 1.5350 | 1.5345 | 1.5340 | 1.5333 | 1.5325 | 1.5317 |
| 0.50 | 1.4724 | 1.4722 | 1.4720 | 1.4718 | 1.4712 | 1.4707 | 1.4700 | 1.4693 | 1.4685 | 1.4676 |
| 0.60 | 1.4200 | 1.4199 | 1.4198 | 1.4195 | 1.4191 | 1.4187 | 1.4175 | 1.4167 | 1.4158 | 1.4149 |
| 0.70 | 1.3757 | 1.3756 | 1.3755 | 1.3752 | 1.3748 | 1.3744 | 1.3738 | 1.3731 | 1.3723 | 1.3714 |
| 0.80 | 1.3375 | 1.3374 | 1.3373 | 1.3370 | 1.3366 | 1.3362 | 1.3356 | 1.3350 | 1.3344 | 1.3338 |
| 0.90 | 1.2975 | 1.2974 | 1.2972 | 1.2971 | 1.2970 | 1.2969 | 1.2967 | 1.2964 | 1.2960 | 1.2957 |

**TABLE I: \( \alpha_1(\tilde{m}, \tilde{r}) \): table of eigenvalues of mode 1 for \( 0 \leq \tilde{m} \leq 2 \) and \( 0 \leq \tilde{r} \leq 0.1 \).**
TABLE II: $\alpha_2(\tilde{m}, \tilde{r})$: table of eigenvalues of mode 2 for $0 \leq \tilde{m} \leq 2$ and $0 \leq \tilde{r} \leq 0.1$.

| $\tilde{r}$ | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 |
|------------|------|------|------|------|------|------|------|------|------|------|------|
| $\tilde{m}$ | 1.00 | 1.01 | 1.02 | 1.03 | 1.04 | 1.05 | 1.06 | 1.07 | 1.08 | 1.09 | 1.10 |
| 1.90 | 7.8548 | 7.8548 | 7.8548 | 7.8548 | 7.8548 | 7.8548 | 7.8548 | 7.8548 | 7.8548 | 7.8548 | 7.8548 |
| 1.10 | 7.4511 | 7.4477 | 7.4457 | 7.4421 | 7.3956 | 7.3635 | 7.3237 | 7.2759 | 7.2202 | 7.1568 | 7.0866 |
| 1.20 | 7.3184 | 7.3127 | 7.2956 | 7.2661 | 7.2252 | 7.1708 | 7.1032 | 0.0230 | 6.9315 | 6.8310 | 6.7248 |
| 1.30 | 7.2537 | 7.2460 | 7.2282 | 7.1833 | 7.1265 | 7.0518 | 6.9595 | 6.8518 | 6.7324 | 6.6066 | 6.4796 |
| 1.40 | 7.2155 | 7.2059 | 7.1769 | 7.1217 | 7.0553 | 6.9609 | 6.8456 | 6.7139 | 6.5727 | 6.4296 | 6.2910 |
| 1.50 | 7.1903 | 7.1789 | 7.1441 | 7.0842 | 0.9974 | 6.8837 | 6.7469 | 6.5946 | 6.4368 | 6.2826 | 6.1383 |
| 1.60 | 7.1725 | 7.1593 | 7.1187 | 7.0485 | 0.9408 | 6.8144 | 6.6577 | 6.4882 | 6.3183 | 6.1575 | 0.6114 |
| 1.70 | 7.1593 | 7.1442 | 7.0979 | 0.7174 | 0.9067 | 6.7501 | 6.5756 | 6.3921 | 6.2137 | 0.4960 | 5.9940 |
| 1.80 | 7.1490 | 7.1321 | 7.0800 | 6.9892 | 6.8575 | 6.6895 | 6.4991 | 6.3045 | 6.1206 | 0.5555 | 5.8121 |
| 1.90 | 7.1408 | 7.1221 | 7.0642 | 6.9630 | 6.8164 | 6.6319 | 6.4276 | 6.2245 | 6.0373 | 0.8728 | 5.7325 |
| 2.00 | 7.1341 | 7.1136 | 7.0499 | 6.9381 | 6.7799 | 6.5769 | 6.3606 | 6.1510 | 5.9623 | 5.7997 | 5.6630 |

TABLE III: $\alpha_3(\tilde{m}, \tilde{r})$: table of eigenvalues of mode 3 for $0 \leq \tilde{m} \leq 2$ and $0 \leq \tilde{r} \leq 0.1$.

| $\tilde{r}$ | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 |
|------------|------|------|------|------|------|------|------|------|------|------|------|
| $\tilde{m}$ | 1.00 | 1.01 | 1.02 | 1.03 | 1.04 | 1.05 | 1.06 | 1.07 | 1.08 | 1.09 | 1.10 |
| 1.90 | 7.2386 | 7.2063 | 7.0367 | 6.9143 | 6.7387 | 6.5242 | 6.2977 | 6.0835 | 5.8945 | 5.7545 | 5.6019 |
| 1.10 | 7.1239 | 7.0998 | 7.0243 | 6.8931 | 6.7015 | 6.4737 | 6.2386 | 6.0212 | 5.8331 | 5.6762 | 5.5477 |
| 1.20 | 7.1199 | 7.0940 | 7.0126 | 6.8689 | 6.6653 | 6.4251 | 6.1830 | 5.9637 | 5.7772 | 5.6237 | 5.4994 |
| 1.30 | 7.1164 | 7.0887 | 7.0013 | 6.8470 | 6.6299 | 6.3786 | 6.1307 | 5.9105 | 5.7262 | 5.5763 | 5.4562 |
| 1.40 | 7.1134 | 7.0838 | 6.9905 | 6.8255 | 6.5954 | 6.3339 | 6.0814 | 5.8612 | 5.6794 | 5.5333 | 5.4172 |
| 1.50 | 7.1108 | 7.0783 | 6.9680 | 6.8043 | 6.5616 | 6.2910 | 6.0349 | 5.8153 | 5.6364 | 5.4941 | 5.3820 |
| 1.60 | 7.1084 | 7.0751 | 6.9697 | 6.8343 | 6.5286 | 6.2498 | 5.9910 | 5.7726 | 5.5968 | 5.4583 | 5.3500 |
| 1.70 | 7.1063 | 7.0712 | 6.9597 | 6.7627 | 6.4964 | 6.2103 | 5.9496 | 5.7328 | 5.5602 | 5.4255 | 5.3208 |
| 1.80 | 7.1044 | 7.0675 | 6.9499 | 6.7423 | 6.4649 | 6.1723 | 5.9104 | 5.6955 | 5.5263 | 5.3953 | 5.2941 |
| 1.90 | 7.1027 | 7.0639 | 6.9402 | 6.7221 | 6.4341 | 6.1359 | 5.8734 | 5.6607 | 5.4949 | 5.3674 | 5.2696 |
### Mode 4: $\alpha_4(\tilde{m}, \tilde{r})$

| $\tilde{r}$ | $\tilde{m}$ | $\alpha_4(\tilde{m}, \tilde{r})$ |
|-------------|-------------|----------------------------------|
| 0.00        | 10.9955     | 10.9955                          |
| 0.10        | 10.5218     | 10.5217                          |
| 0.20        | 10.4016     | 10.3862                          |
| 0.30        | 10.3480     | 10.3269                          |
| 0.40        | 10.3178     | 10.2910                          |
| 0.50        | 10.2984     | 10.2660                          |
| 0.60        | 10.2850     | 10.2469                          |
| 0.70        | 10.2751     | 10.2313                          |
| 0.80        | 10.2675     | 10.2181                          |
| 0.90        | 10.2615     | 10.2064                          |
| 1.00        | 10.2566     | 10.1958                          |
| 1.10        | 10.2526     | 10.1860                          |
| 1.20        | 10.2492     | 10.1768                          |
| 1.30        | 10.2463     | 10.1681                          |
| 1.40        | 10.2438     | 10.1597                          |
| 1.50        | 10.2417     | 10.1516                          |
| 1.60        | 10.2398     | 10.1438                          |
| 1.70        | 10.2381     | 10.1361                          |
| 1.80        | 10.2366     | 10.1286                          |
| 1.90        | 10.2352     | 10.1212                          |
| 2.00        | 10.2340     | 10.1139                          |

**TABLE IV:** $\alpha_4(\tilde{m}, \tilde{r})$: table of eigenvalues of mode 4 for $0 \leq \tilde{m} \leq 2$ and $0 \leq \tilde{r} \leq 0.1$.

### Mode 5: $\alpha_5(\tilde{m}, \tilde{r})$

| $\tilde{r}$ | $\tilde{m}$ | $\alpha_5(\tilde{m}, \tilde{r})$ |
|-------------|-------------|----------------------------------|
| 0.00        | 14.1372     | 14.1372                          |
| 0.10        | 13.6142     | 13.5953                          |
| 0.20        | 13.5067     | 13.4742                          |
| 0.30        | 13.4615     | 13.4160                          |
| 0.40        | 13.4367     | 13.3782                          |
| 0.50        | 13.4210     | 13.3949                          |
| 0.60        | 13.4102     | 13.3523                          |
| 0.70        | 13.4023     | 13.3040                          |
| 0.80        | 13.3963     | 13.2843                          |
| 0.90        | 13.3916     | 13.2658                          |
| 1.00        | 13.3878     | 13.2479                          |
| 1.10        | 13.3846     | 13.2305                          |
| 1.20        | 13.3820     | 13.2134                          |
| 1.30        | 13.3797     | 13.1966                          |
| 1.40        | 13.3778     | 13.1798                          |
| 1.50        | 13.3761     | 13.1632                          |
| 1.60        | 13.3746     | 13.1465                          |
| 1.70        | 13.3733     | 13.1329                          |
| 1.80        | 13.3721     | 13.1132                          |
| 1.90        | 13.3711     | 13.0966                          |
| 2.00        | 13.3701     | 13.0798                          |

**TABLE V:** $\alpha_5(\tilde{m}, \tilde{r})$: table of eigenvalues of mode 5 for $0 \leq \tilde{m} \leq 2$ and $0 \leq \tilde{r} \leq 0.1$.