# Supplementary information for

# A Vacuum Ultraviolet Photoionization Study on the Formation of Methanimine (CH2NH) and Ethylenediamine (NH2CH2CH2NH2) in Low Temperature Interstellar Model Ices Exposed to Ionizing Radiation

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**Table S1** Data applied to calculate the irradiation dose per molecule. \* values from CASINO simulations, $ derived values based on 15 nA, 20 min irradiation of CH3NH2.

|  |  |
| --- | --- |
| initial kinetic energy of the electrons, Einit | 5 keV |
| irradiation current, I | 20 ± 2 nA |
| total number of electrons  | (1.1 ± 0.3)×1014 |
| average kinetic energy of backscattered electrons, Ebs\* | 3.1 ± 0.3 keV |
| fraction of backscattered electrons, fbs\* | 0.3 ± 0.1 |
| average kinetic energy of transmitted electrons, Etrans\*,  | 2.9 ± 0.3 keV |
| fraction of transmitted electrons, ftrans\* | 0.5 |
| average penetration depth, l\* | 180 ± 80 nm |
| density of the ice, ρ | 0.85 ± 0.05 g cm-3 |
| irradiated area, A | 1.0 ± 0.1 cm2 |
| total number of molecules processed$ | (3 ± 1)×1017 |
| dose per molecule, D$ | 1.0 ± 0.1 eV |

**Table S2** Theoretical values for the molecule geometry of CNH3 and C2N2H8 isomers and their ions.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **H2CNH** | **H2CNH+** |
| C | 0.584348  | 0.028954  | 0.000407  | C | 0.598498  | 0.023834  | -0.000021  |
| H | -1.166258  | 0.735956  | -0.000251  | H | -1.561096  | 0.309440  | -0.000069  |
| H | 1.075482  | 1.006604  | -0.000763  | H | 1.071217  | 1.022722  | 0.000044  |
| H | 1.244023  | -0.838535  | -0.000968  | H | 1.245402  | -0.864826  | 0.000009  |
| N | -0.665619  | -0.153964  | -0.000066  | N | -0.620931  | -0.087191  | 0.000021  |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **3CH3N** | **3CH3N+** |
| C | 0.000000  | 0.000000  | -0.542736  | C | 0.000000  | 0.000000  | -0.661067  |
| H | 0.000000  | 1.027837  | -0.935418  | H | 0.000000  | 1.076160  | -0.862293  |
| H | -0.890133  | -0.513918  | -0.935418  | H | -0.931982  | -0.538080  | -0.862293  |
| H | 0.890133  | -0.513918  | -0.935418  | H | 0.931982  | -0.538080  | -0.862293  |
| N | 0.000000  | 0.000000  | 0.866096  | N | 0.000000  | 0.000000  | 0.936183  |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **CHNH2** | **CHNH2+** |
| C | -0.763425  | 0.191020  | -0.000052  | C | -0.708468  | 0.155030  | -0.000061  |
| H | -1.247136  | -0.803479  | 0.000169  | H | -1.572427  | -0.505327  | 0.000151  |
| N | 0.525142  | -0.024423  | 0.000051  | N | 0.527230  | -0.030424  | 0.000071  |
| H | 1.162890  | 0.760881  | 0.000002  | H | 1.183835  | 0.756126  | -0.000072  |
| H | 0.988801  | -0.932556  | -0.000216  | H | 0.948786  | -0.968009  | -0.000209  |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **3CHNH2** | **3CHNH2+** |
| C | -0.768492  | -0.000134  | 0.172029  | C | -0.849378  | 0.000034  | 0.156575  |
| H | -1.560245  | 0.000521  | -0.576784  | H | -1.468652  | -0.000260  | -0.741014  |
| N | 0.571054  | -0.000018  | -0.107523  | N | 0.616161  | -0.000017  | 0.018755  |
| H | 1.086806  | 0.834059  | 0.148853  | H | 1.125711  | 0.875811  | -0.164974  |
| H | 1.087013  | -0.833653  | 0.148415  | H | 1.126085  | -0.875639  | -0.164752  |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **CH3NHNHCH3** | **CH3NHNHCH3+** |
| C | -0.016087  | 1.827841  | 0.099439  | C | -0.057850  | 1.881992  | 0.132329  |
| H | 0.653402  | 2.003275  | 0.944607  | H | 0.649709  | 1.977094  | 0.954431  |
| H | 0.205281  | 2.581493  | -0.656072  | H | 0.228114  | 2.564111  | -0.663288  |
| H | -1.048326  | 1.952461  | 0.449831  | H | -1.065870  | 2.120303  | 0.477022  |
| N | 0.249943  | 0.509348  | -0.466674  | N | -0.002265  | 0.526287  | -0.399047  |
| H | -0.350222  | 0.404574  | -1.280016  | H | -0.296266  | 0.340675  | -1.350792  |
| N | -0.249943  | -0.509348  | 0.466674  | N | 0.002265  | -0.526287  | 0.399047  |
| H | 0.350222  | -0.404574  | 1.280016  | H | 0.296266  | -0.340675  | 1.350792  |
| C | 0.016087  | -1.827841  | -0.099439  | C | 0.057850  | -1.881992  | -0.132329  |
| H | 1.048326  | -1.952461  | -0.449831  | H | 1.065870  | -2.120303  | -0.477022  |
| H | -0.205281  | -2.581493  | 0.656072  | H | -0.228114  | -2.564111  | 0.663288  |
| H | -0.653402  | -2.003275  | -0.944607  | H | -0.649709  | -1.977094  | -0.954431  |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **H2NCH2CH2NH2** | **H2NCH2CH2NH2+** |
| N | 1.467235  | -0.558223  | -0.238485  | N | 1.649073  | -0.482818  | -0.106493  |
| H | 2.352613  | -0.666632  | 0.239672  | H | 2.163214  | -0.404393  | -0.970051  |
| H | 0.922827  | -1.396268  | -0.067161  | H | 1.692992  | -1.372142  | 0.365271  |
| C | 0.725558  | 0.587047  | 0.284633  | C | 0.869475  | 0.527303  | 0.347502  |
| H | 1.237868  | 1.506806  | -0.008397  | H | 1.159132  | 1.509213  | -0.013010  |
| H | 0.648177  | 0.603502  | 1.384140  | H | 0.647637  | 0.483105  | 1.407339  |
| C | -0.681973  | 0.600997  | -0.297080  | C | -0.869467  | 0.527333  | -0.347489  |
| H | -1.175813  | 1.543276  | -0.025829  | H | -1.159102  | 1.509233  | 0.013070  |
| H | -0.603702  | 0.569982  | -1.384980  | H | -0.647638  | 0.483171  | -1.407330  |
| N | -1.419651  | -0.594061  | 0.133800  | N | -1.649103  | -0.482808  | 0.106466  |
| H | -1.724299  | -0.496049  | 1.095300  | H | -2.163045  | -0.404507  | 0.970153  |
| H | -2.252264  | -0.726897  | -0.425272  | H | -1.693030  | -1.372111  | -0.365331  |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **H2NCH2NHCH3** | **H2NCH2NHCH3+** |
| N | -1.460052  | -0.588360  | -0.115897  | N | -1.350176  | -0.650407  | -0.007934  |
| H | -2.302382  | -0.661056  | 0.440246  | H | -1.612240  | -1.020626  | 0.893078  |
| H | -1.728228  | -0.501483  | -1.088763  | H | -2.064393  | -0.813112  | -0.699780  |
| C | -0.663079  | 0.563795  | 0.288990  | C | -0.792651  | 0.639634  | -0.008171  |
| H | -0.568907  | 0.512536  | 1.386199  | H | -1.060042  | 1.262483  | 0.862094  |
| H | -1.121452  | 1.531975  | 0.046790  | H | -1.077541  | 1.228444  | -0.888505  |
| N | 0.617793  | 0.523231  | -0.390331  | N | 0.681601  | 0.622304  | 0.007315  |
| H | 1.046401  | 1.438247  | -0.364617  | H | 1.140402  | 1.522759  | 0.134171  |
| C | 1.536167  | -0.490360  | 0.113919  | C | 1.497535  | -0.547831  | -0.033942  |
| H | 2.462071  | -0.463399  | -0.460416  | H | 2.431510  | -0.319606  | -0.547820  |
| H | 1.784731  | -0.369104  | 1.179809  | H | 1.757270  | -0.853577  | 0.992699  |
| H | 1.085060  | -1.472425  | -0.013101  | H | 0.935754  | -1.360861  | -0.488921  |
| Atom | X | Y | Z | Atom | X | Y | Z |
| **(CH3)2NNH2** | **(CH3)2NNH2+** |
| N | -0.328929  | 0.239419  | 0.000000  | N | -0.105641  | 0.050367  | 0.000000  |
| C | -0.328929  | -0.587433  | 1.196851  | C | -0.105641  | -0.670272  | 1.268283  |
| H | -0.345336  | 0.048620  | 2.083676  | H | -0.378963  | 0.006386  | 2.075107  |
| H | -1.232089  | -1.196438  | 1.205462  | H | -0.833915  | -1.473896  | 1.205842  |
| H | 0.552509  | -1.243562  | 1.256237  | H | 0.885488  | -1.089656  | 1.458005  |
| C | -0.328929  | -0.587433  | -1.196851  | C | -0.105641  | -0.670272  | -1.268283  |
| H | -1.232089  | -1.196438  | -1.205462  | H | -0.833915  | -1.473896  | -1.205842  |
| H | -0.345336  | 0.048620  | -2.083676  | H | -0.378963  | 0.006386  | -2.075107  |
| H | 0.552509  | -1.243562  | -1.256237  | H | 0.885488  | -1.089656  | -1.458005  |
| N | 0.937043  | 0.989579  | 0.000000  | N | 0.312886  | 1.308805  | 0.000000  |
| H | 0.870093  | 1.614486  | -0.801011  | H | 0.235876  | 1.821698  | -0.868229  |
| H | 0.870093  | 1.614486  | 0.801011  | H | 0.235876  | 1.821698  | 0.868229  |

**Table S3** Theoretical infrared frequency modes for the CNH3 and C2N2H8 isomers and their ions.

|  |  |
| --- | --- |
| H2CNH | H2CNH+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 1075.5062  | 37.0005  | ν1 | 582.8914  | 118.9476  |
| 2 | 1101.4124  | 15.5365  | ν2 | 633.3062  | 132.9916  |
| 3 | 1170.0398  | 45.5313  | ν3 | 987.4739  | 10.3758  |
| 4 | 1373.3046  | 46.9702  | ν4 | 1058.5386  | 53.2054  |
| 5 | 1492.8412  | 6.5260  | ν5 | 1341.6707  | 63.0830  |
| 6 | 1713.0952  | 21.6437  | ν6 | 1730.4488  | 0.4752  |
| 7 | 3010.4982  | 52.4169  | ν7 | 2914.2190  | 105.7087  |
| 8 | 3103.8095  | 36.8335  | ν8 | 3028.5777  | 87.9035  |
| 9 | 3425.8292  | 1.0857  | ν9 | 3507.1840  | 387.2770  |
| 3CH3N | 3CH3N+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 963.5507 | 0.7019 | ν1 | 466.3037 | 8.6117 |
| 2 | 963.5524 | 0.7019 | ν2 | 898.2116 | 7.7179 |
| 3 | 1053.8599 | 4.9809 | ν3 | 898.2128 | 7.7178 |
| 4 | 1379.2879 | 13.3115 | ν4 | 1320.4751 | 0.1288 |
| 5 | 1419.7884 | 9.9782 | ν5 | 1352.6705 | 13.6947 |
| 6 | 1419.7887 | 9.9775 | ν6 | 1352.672 | 13.6931 |
| 7 | 2924.4886 | 2.4306 | ν7 | 2968.3363 | 63.0607 |
| 8 | 2979.3148 | 14.2024 | ν8 | 3112.1254 | 89.7423 |
| 9 | 2979.315 | 14.2047 | ν9 | 3112.1258 | 89.7373 |
| CHNH2 | CHNH2+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 801.4767 | 147.4518 | ν1 | 845.2991 | 35.7408 |
| 2 | 1075.3634 | 25.535 | ν2 | 893.2671 | 182.5151 |
| 3 | 1159.0683 | 12.2723 | ν3 | 965.3992 | 42.6828 |
| 4 | 1387.5623 | 12.7364 | ν4 | 1177.4118 | 15.2562 |
| 5 | 1438.5902 | 13.3644 | ν5 | 1565.7474 | 30.102 |
| 6 | 1686.9227 | 11.4576 | ν6 | 1728.7476 | 91.2312 |
| 7 | 2913.9804 | 110.6138 | ν7 | 3172.483 | 60.0396 |
| 8 | 3369.3698 | 22.9474 | ν8 | 3337.5861 | 159.5816 |
| 9 | 3534.9723 | 15.4043 | ν9 | 3439.4942 | 216.8281 |
| 3CHNH2 | 3CHNH2+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 520.137 | 30.9842 | ν1 | 569.0733 | 17.2517 |
| 2 | 610.4615 | 219.6403 | ν2 | 715.1091 | 116.3377 |
| 3 | 1070.3104 | 17.7116 | ν3 | 955.8706 | 34.4621 |
| 4 | 1099.6283 | 1.1623 | ν4 | 972.5576 | 8.0127 |
| 5 | 1267.8758 | 18.2884 | ν5 | 1110.2469 | 3.7313 |
| 6 | 1625.8034 | 22.7909 | ν6 | 1555.383 | 42.3441 |
| 7 | 3063.6355 | 30.2464 | ν7 | 3104.1286 | 49.0516 |
| 8 | 3464.8578 | 3.4299 | ν8 | 3316.4336 | 80.4391 |
| 9 | 3531.5805 | 14.6469 | ν9 | 3421.6898 | 194.3654 |
| CH3NHNHCH3 | CH3NHNHCH3+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 49.7107  | 6.3924  | ν1 | 112.8545  | 0.0751  |
| 2 | 234.2774  | 0.9594  | ν2 | 148.8191  | 3.1889  |
| 3 | 285.3485  | 0.0000  | ν3 | 155.5647  | 0.0000  |
| 4 | 292.0175  | 5.1310  | ν4 | 294.0692  | 1.9831  |
| 5 | 474.4309  | 0.0000  | ν5 | 402.9769  | 0.0000  |
| 6 | 815.9057  | 0.0000  | ν6 | 511.8491  | 0.0000  |
| 7 | 892.8219  | 132.1914  | ν7 | 590.0594  | 168.2007  |
| 8 | 960.6316  | 0.0000  | ν8 | 922.7047  | 0.0000  |
| 9 | 1044.4290  | 25.9933  | ν9 | 1026.3576  | 14.7526  |
| 10 | 1106.7215  | 0.0000  | ν10 | 1121.8020  | 24.6704  |
| 11 | 1108.4551  | 14.1059  | ν11 | 1123.8278  | 0.0000  |
| 12 | 1151.7854  | 12.4246  | ν12 | 1128.0659  | 1.6143  |
| 13 | 1181.2046  | 0.0000  | ν13 | 1220.7657  | 0.0000  |
| 14 | 1292.2594  | 0.0000  | ν14 | 1402.7582  | 0.0000  |
| 15 | 1431.1926  | 5.1148  | ν15 | 1432.3455  | 12.6587  |
| 16 | 1446.5412  | 4.7441  | ν16 | 1464.1766  | 5.2859  |
| 17 | 1446.7211  | 0.0000  | ν17 | 1468.4634  | 0.0000  |
| 18 | 1479.2835  | 0.0000  | ν18 | 1476.7806  | 29.2365  |
| 19 | 1483.8601  | 13.7356  | ν19 | 1479.2059  | 0.0000  |
| 20 | 1515.4655  | 22.3501  | ν20 | 1500.0455  | 0.0000  |
| 21 | 1517.1866  | 0.0000  | ν21 | 1505.3241  | 65.2002  |
| 22 | 1538.4557  | 0.0000  | ν22 | 1612.1145  | 0.0000  |
| 23 | 2973.5900  | 160.9774  | ν23 | 3038.1648  | 0.0000  |
| 24 | 2976.7763  | 0.0000  | ν24 | 3038.5829  | 2.2985  |
| 25 | 3046.5231  | 78.8358  | ν25 | 3116.4385  | 0.2815  |
| 26 | 3046.6431  | 0.0000  | ν26 | 3117.2818  | 0.0000  |
| 27 | 3095.6242  | 50.5520  | ν27 | 3156.6600  | 1.2636  |
| 28 | 3095.7023  | 0.0000  | ν28 | 3157.0660  | 0.0000  |
| 29 | 3450.0833  | 0.0000  | ν29 | 3548.2904  | 0.0000  |
| 30 | 3471.0086  | 0.0657  | ν30 | 3557.5745  | 168.3875  |
| (CH3)2NNH2 | (CH3)2NNH2+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 164.5265  | 36.2334  | ν1 | 100.5343  | 0.0109  |
| 2 | 262.6485  | 7.0780  | ν2 | 137.5117  | 0.3196  |
| 3 | 274.4501  | 0.0136  | ν3 | 291.3740  | 11.5028  |
| 4 | 408.7494  | 4.3265  | ν4 | 404.9324  | 10.2624  |
| 5 | 436.2408  | 1.8204  | ν5 | 409.7203  | 3.1825  |
| 6 | 439.5743  | 16.7883  | ν6 | 468.9608  | 0.0372  |
| 7 | 811.4670  | 14.3654  | ν7 | 527.4746  | 191.1342  |
| 8 | 982.7986  | 20.2362  | ν8 | 798.0330  | 1.1307  |
| 9 | 1039.6479  | 14.8111  | ν9 | 1027.9332  | 13.9603  |
| 10 | 1107.2052  | 0.6997  | ν10 | 1086.7726  | 4.0227  |
| 11 | 1116.1826  | 60.2056  | ν11 | 1111.9567  | 0.9131  |
| 12 | 1132.4435  | 10.5313  | ν12 | 1137.1129  | 2.2901  |
| 13 | 1199.1632  | 4.5031  | ν13 | 1159.6141  | 3.3527  |
| 14 | 1256.8760  | 0.2674  | ν14 | 1389.1960  | 0.8233  |
| 15 | 1396.6579  | 5.0630  | ν15 | 1425.1564  | 14.3774  |
| 16 | 1433.1014  | 0.9195  | ν16 | 1448.8353  | 1.2036  |
| 17 | 1460.5832  | 2.7575  | ν17 | 1465.7927  | 14.8286  |
| 18 | 1477.4936  | 9.1040  | ν18 | 1468.5245  | 0.0053  |
| 19 | 1487.7995  | 8.9362  | ν19 | 1487.3965  | 9.4913  |
| 20 | 1497.8457  | 0.2099  | ν20 | 1488.6399  | 23.4394  |
| 21 | 1511.7046  | 11.5259  | ν21 | 1526.7873  | 14.2940  |
| 22 | 1650.6901  | 34.0909  | ν22 | 1659.5838  | 79.5095  |
| 23 | 2942.0905  | 46.2139  | ν23 | 3031.4526  | 0.3176  |
| 24 | 2950.5747  | 105.9159  | ν24 | 3035.2911  | 1.5530  |
| 25 | 3051.9818  | 43.5185  | ν25 | 3117.8989  | 0.2308  |
| 26 | 3054.6447  | 30.7283  | ν26 | 3118.8408  | 0.0931  |
| 27 | 3097.9984  | 6.0858  | ν27 | 3156.4993  | 0.0642  |
| 28 | 3103.3640  | 44.1226  | ν28 | 3161.0826  | 0.6534  |
| 29 | 3421.1784  | 1.7475  | ν29 | 3513.6341  | 121.0814  |
| 30 | 3498.3215  | 0.0350  | ν30 | 3645.6045  | 106.4104  |
| NH2CH2CH2NH2 | NH2CH2CH2NH2+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 179.9656  | 4.2047  | ν1 | 118.9283  | 0.4519  |
| 2 | 235.6987  | 20.7799  | ν2 | 173.5474  | 0.0577  |
| 3 | 290.2833  | 44.0429  | ν3 | 334.9658  | 0.2470  |
| 4 | 348.0012  | 22.5367  | ν4 | 375.9995  | 3.6233  |
| 5 | 504.1945  | 12.0775  | ν5 | 417.6388  | 88.9136  |
| 6 | 812.9440  | 91.1544  | ν6 | 472.3067  | 13.0408  |
| 7 | 853.7207  | 75.6127  | ν7 | 516.2050  | 260.7918  |
| 8 | 878.8733  | 79.2875  | ν8 | 518.9747  | 19.2435  |
| 9 | 927.4051  | 34.2551  | ν9 | 826.9022  | 12.9578  |
| 10 | 1007.0535  | 12.4586  | ν10 | 865.4095  | 4.4735  |
| 11 | 1050.4762  | 8.4471  | ν11 | 1030.8206  | 9.5415  |
| 12 | 1111.8972  | 5.2103  | ν12 | 1073.0899  | 0.2365  |
| 13 | 1182.9452  | 4.0095  | ν13 | 1116.1998  | 0.1456  |
| 14 | 1219.1725  | 4.7418  | ν14 | 1219.8789  | 1.0774  |
| 15 | 1325.2989  | 3.0479  | ν15 | 1282.5953  | 69.0741  |
| 16 | 1342.2669  | 2.1699  | ν16 | 1290.7199  | 7.8323  |
| 17 | 1408.0343  | 8.9275  | ν17 | 1351.8296  | 3.2982  |
| 18 | 1431.9029  | 6.5813  | ν18 | 1355.1309  | 2.5404  |
| 19 | 1498.5561  | 4.4343  | ν19 | 1498.4649  | 10.5689  |
| 20 | 1511.8609  | 3.3838  | ν20 | 1500.7886  | 3.6261  |
| 21 | 1643.5125  | 35.9144  | ν21 | 1669.0592  | 61.4084  |
| 22 | 1655.7046  | 25.0305  | ν22 | 1673.0249  | 61.3540  |
| 23 | 2913.0618  | 90.1722  | ν23 | 3094.1370  | 6.9372  |
| 24 | 2963.3322  | 84.6318  | ν24 | 3100.5815  | 0.0027  |
| 25 | 3036.8892  | 48.2593  | ν25 | 3192.4228  | 0.3734  |
| 26 | 3064.3194  | 31.7873  | ν26 | 3196.4396  | 0.1725  |
| 27 | 3487.5711  | 4.5441  | ν27 | 3555.6620  | 303.5859  |
| 28 | 3492.3403  | 0.2313  | ν28 | 3566.9258  | 70.1105  |
| 29 | 3568.3256  | 3.0076  | ν29 | 3674.4148  | 121.0612  |
| 30 | 3573.3657  | 0.9236  | ν30 | 3674.6780  | 59.1663  |
| H2NCH2NHCH3 | H2NCH2NHCH3+ |
| Normal modes | Frequency(cm-1) | IR Intensity | Normal modes | Frequency(cm-1) | IR Intensity |
| 1 | 155.5951  | 3.0447  | ν1 | 110.8234  | 9.5533  |
| 2 | 199.3598  | 3.9098  | ν2 | 136.7661  | 3.8321  |
| 3 | 256.3639  | 43.6882  | ν3 | 229.1249  | 21.1248  |
| 4 | 354.2506  | 2.7450  | ν4 | 298.3746  | 1.4209  |
| 5 | 517.6992  | 6.6231  | ν5 | 520.0678  | 99.4510  |
| 6 | 742.3573  | 133.3957  | ν6 | 627.0610  | 60.7215  |
| 7 | 832.5152  | 105.1208  | ν7 | 641.4707  | 76.2000  |
| 8 | 905.6845  | 8.3208  | ν8 | 786.4589  | 3.2459  |
| 9 | 999.4335  | 10.5407  | ν9 | 832.3506  | 14.4057  |
| 10 | 1041.1852  | 13.1506  | ν10 | 1017.4395  | 41.2582  |
| 11 | 1139.8032  | 3.4008  | ν11 | 1057.1552  | 6.1410  |
| 12 | 1169.3373  | 64.2341  | ν12 | 1120.2903  | 26.2495  |
| 13 | 1182.3384  | 10.8405  | ν13 | 1170.1044  | 9.7959  |
| 14 | 1249.0761  | 8.9192  | ν14 | 1195.4672  | 7.1864  |
| 15 | 1338.5552  | 2.4211  | ν15 | 1306.6047  | 9.4839  |
| 16 | 1426.8185  | 24.4433  | ν16 | 1367.2696  | 0.9236  |
| 17 | 1455.9869  | 13.7573  | ν17 | 1383.2562  | 31.6166  |
| 18 | 1487.4081  | 12.6813  | ν18 | 1423.0346  | 10.0826  |
| 19 | 1496.4614  | 0.8865  | ν19 | 1427.8173  | 31.8465  |
| 20 | 1517.9698  | 3.0244  | ν20 | 1461.8472  | 28.6748  |
| 21 | 1523.9726  | 6.8419  | ν21 | 1494.9044  | 12.1352  |
| 22 | 1639.8778  | 30.8845  | ν22 | 1672.7270  | 48.4770  |
| 23 | 2913.6289  | 97.5123  | ν23 | 2927.5904  | 60.8846  |
| 24 | 2933.2343  | 115.6178  | ν24 | 2945.0094  | 24.0464  |
| 25 | 2958.2492  | 91.4081  | ν25 | 3009.4568  | 4.5659  |
| 26 | 3068.2083  | 37.6601  | ν26 | 3068.4715  | 5.5108  |
| 27 | 3113.2954  | 14.8337  | ν27 | 3143.3810  | 20.4867  |
| 28 | 3494.2785  | 0.3165  | ν28 | 3494.4745  | 99.8736  |
| 29 | 3541.8180  | 0.3031  | ν29 | 3562.3324  | 83.0464  |
| 30 | 3582.3946  | 0.8282  | ν30 | 3653.6543  | 68.2966  |