

How to detect interstellar NT glycine while observing the night sky with an IR telescope or IR camera?

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Neutral Glycine (NT Glycine) is one of the essential amino acids that composes proteic or peptidic sequences of living organisms and is therefore, in its own merit, an important indicator of life in the Universe. Scientists have been searching for this molecule ‘interstellarly’ for quite a while, without great promise, aside from the Murchison meteorite which was inspected after hitting the ground and revealed the presence of glycine along with that of the other amino acids. In reality, it isn’t surprising that meteorites and some other celestial bodies like comets, would carry such fragments of life, as they are apt to travelling in proximity to the earth, and, by doing so, they could assimilate the amino acids from the earth’s atmosphere, which has been capable of forming these peptides from methane since its origins.

Nevertheless, probing these building blocks of life from scratch in faraway galaxies, nebulae, exoplanets or other star clusters, requires highly sophisticated instruments, and is very difficult to achieve due to their distance from earth itself.

To do so, astrophysicists namely use infrared spectroscopy integrated with either astronomical interferometers, or telescopes, or even digital cameras, permitting them to obtain a lot of information at high resolutions. The subsequent selection of classic parallax methods to measure the distance in arcsec or parsec is then picked by astronomers, whereas astrobiologists prefer a method a step forward which is based on speed of light (km/s) calculations (indirect analysis). This is done in parallel with the recording of IR spectra directly from the instrument (direct analysis). Conversely, interpretation of the spectral lines to the level of certainty that would allow an observer the confirmation that in fact NT glycine has been uncovered, would require a specific type of approach, in sooth, the most accurate one.

Amino acids that are inspected with telescopes can be at either liquid, gaseous or solid state, but naturally, in faraway celestial nebulas and star clusters, the expectation is that if any amino acid was to be found it would be in a gaseous state, due to the austere temperature conditions enclosed in the interstellar medium, not necessarily yet, as their phase would depend on the brightness, nature, surroundings and distance of the examined celestial media.

THE CONNECTION BETWEEN VIBRATIONAL DYNAMICS (VD) AND TELESCOPE MEASUREMENTS

Previous work has shown that vibrational dynamics (VD)¹ is a technique which allows us to calculate the density of states of any material, paradoxically, organic too. In truth, the vibrational modes of NT glycine have been investigated and compared to experimental Raman/IR spectra of the same compound, already proving that this method increments the accuracy of experimental readings and can be used as '*blank*' for testing before the experimental stage.

Main advantage. The amount of noise registered by telescopes and thus the standard deviation of the acquired values is usually very bulky, conceding that the use of a *blank* for reference can be

of help to exclude differential ‘chemical stamps/spectra’. A notorious example is the revelation of glycine’s precursor protein aminoacetonitrile misinterpreted by many astrophysicists as NT glycine in 2003, chiefly due to not just *errata*, but to the fact that precursor compounds are similar in structure (the C-N peaks had been principally recognized, which unexclusively could characterise both glycine and aminoacetonitrile).

‘Prognostic’ advantage. The frequencies (expressed in cm^{-1}) computed by the vibrational dynamics software provide an accurate descriptive spectrum of NT glycine, anticipating the identifiable frequencies (peaks) which can then be explored with astronomical devices/telescopes² and allow to disregard ‘noisy’ standalone volatiles (i.e. CO_2 , H_2O , etc.).

POTENTIAL NT GLYCINE WAVELENGTHS

The NT Glycine wavelengths (microns) that could be sightseen with IR-astronomical devices in the future are thereby represented. All the key wavelengths should be considered as a whole and define the NT Glycine structure exclusively, acting as an identification stamp for the molecule (Table I). It can be noted that both the C-N, C-H stretch, O-H and C-O-O regions are relevant to discount molecular variants.

Table I. The table illustrates accurate key modes obtained with the VD calculations (GULPTM)¹ and the corresponding wavelengths that should be expected to be observed with the aid of infrared telescopes². A single Spitzer³ exemplary measurement has been included and demonstrates the precision of values already visible with the computed frequencies. The wavenumber is then converted to wavelength (microns), which is standard unit to most telescopes. The wavenumber-wavelength relationship trend is of a hyperbola with formula $y=10^5/x$.

Wavenumber (cm^{-1}) GULP Calculations	Wavelength Λ (μm)	Spitzer ³ Measurements λ (μm)	Standard deviation	Assignment
106	94.33			C-N-C deformation
265	37.74			C-N-C deformation
530	18.87			C-O-O rock
689	14.51	14.10	0.2926	C-N torsion

954	10.48	CH-NH wag
1007	9.930	C-O torsion (carboxyl)
1378	7.257	HCN, CN, CO, CC stretches
1537	6.506	NH ₂ scissors, CN stretch
1590	6.289	NH ₂ asymmetric bend
1696	5.896	CH, NH stretches
1802	5.549	CO stretch, OH bend
2597	3.851	C-H stretch
2915	3.431	C-H stretch
2968	3.369	C-H asymmetric bend, stretch
3233	3.093	NH stretch
3339	2.995	OH, NH stretches

CONCLUDING REMARKS

Although interstellar NT glycine has not yet been found in faraway galaxies, aside from on comets and on Murchison, it is still a molecule of interest to many astronomers; many whom have ventured in its search have detected bits of spectral lines that may be assimilated to the NT glycine structure initially, but which later turned out to be the precursor compound aminoacetonitrile. The reason for this misinterpretation, apart from the fact that the typical C-O-O region of glycine which was undetected in aminoacetonitrile was not considered, is due to the elevated noise levels during telescope readings which could be reduced by seeking the precise and accurate wavelengths computed by vibrational dynamics (VD) studies.

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References

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SUPPLEMENTARY MATERIAL

