Supplementary Information

New Pair of 2-Amino-naphthoxazoles Derived from β-Lapachone: Synthesis, Spectral Evaluation and Crystal Structure

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Spectroscopic data and physical properties data of compound **2**

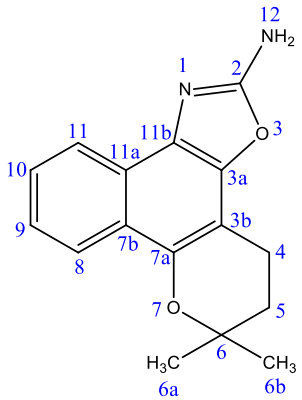

Figure S1. Chemical structure of 6,6-dimethyl-5,6-dihydro-4*H*-benzo[7,8]chromeno[6,5-*d*][1,3]oxazol-2-amine (compound **2**).

6,6-Dimethyl-5,6-dihydro-4*H*-benzo[7,8]chromeno[6,5-*d*][1,3]oxazol-2-amine (**2**)

mp 205-208 ºC; UV-Vis (MeOH) λ / nm 210, 249, 330; FTIR-ATR ν / cm^{-1} 3423, 3419, 3402, 3381, 3290, 3050, 2971, 2950, 1662, 1633, 1589, 1459, 1407, 1367, 1324, 1161, 1122, 1047, 1010, 958, 883, 858, 763; Raman ν / cm^{-1} 3074, 2974, 2931, 1658, 1610, 1570, 1531, 1462, 1402, 1377, 1344, 1329, 1276, 1167, 1049, 1010, 970, 746; ^{1}H NMR (500 MHz, DMSO-d_6) δ 1.39 (s, 6H, CH_3 × 2), 1.9 (t, 2H, *J* 6.62 Hz, CH_2), 2.92 (t, 2H, *J* 6.62 Hz, CH_2), 7.2 (s, 2H, NH_2), 7.37 (t, 1H, *J* 7.57 Hz, CH), 7.47 (t, 1H, *J* 7.25 Hz, CH), 8.01 (d, 1H, *J* 7.88 Hz, CH), 8.08 (d, 1H, *J* 8.51 Hz, CH); ^{13}C NMR (125 MHz, DMSO-d_6) δ 17.5, 26.8, 31.6, 74.8, 102.6, 121.8, 122.5, 123.5 (2C), 123.7, 125.9, 129.8, 143.2, 143.4, 162.1; HRMS (time of flight (TOF) MS electron spray ionization (ESI)+, MeOH-H_2O-0.1%-AcOH) *m/z*, calcd. for $C_{16}H_{17}N_2O_2$ $[M + H]^+$: 269.1285, found: 269.1286.

*e-mail: leonardoaraujo@ufrrj.br
[†]*In memoriam.*

Experimental Raman and infrared spectra of compound **2**

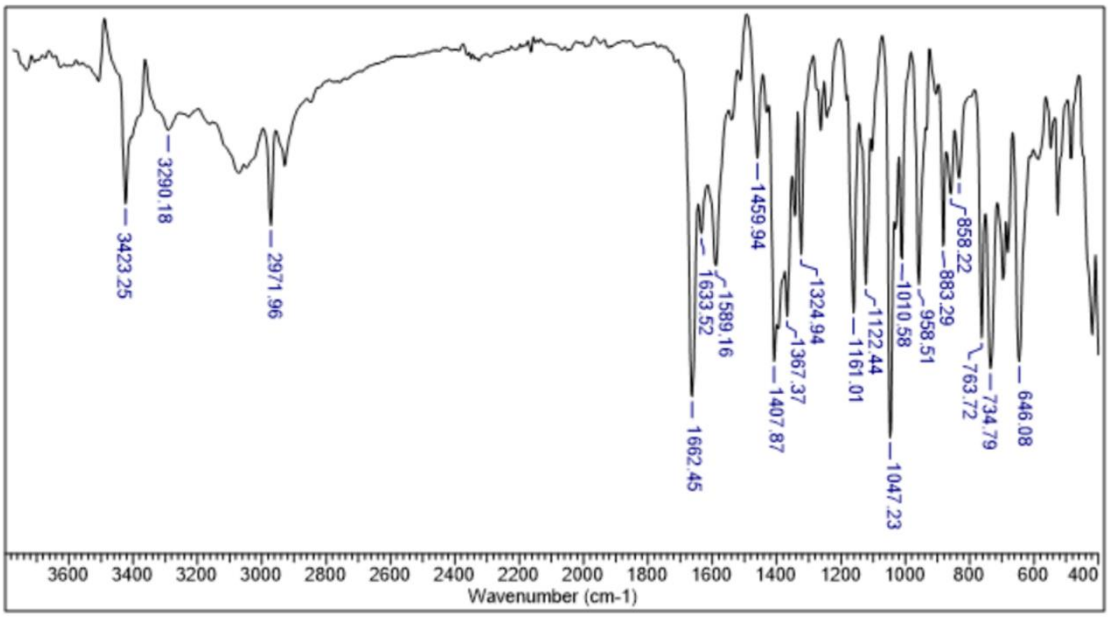

Figure S2. Experimental FTIR-ATR spectrum of compound **2**.

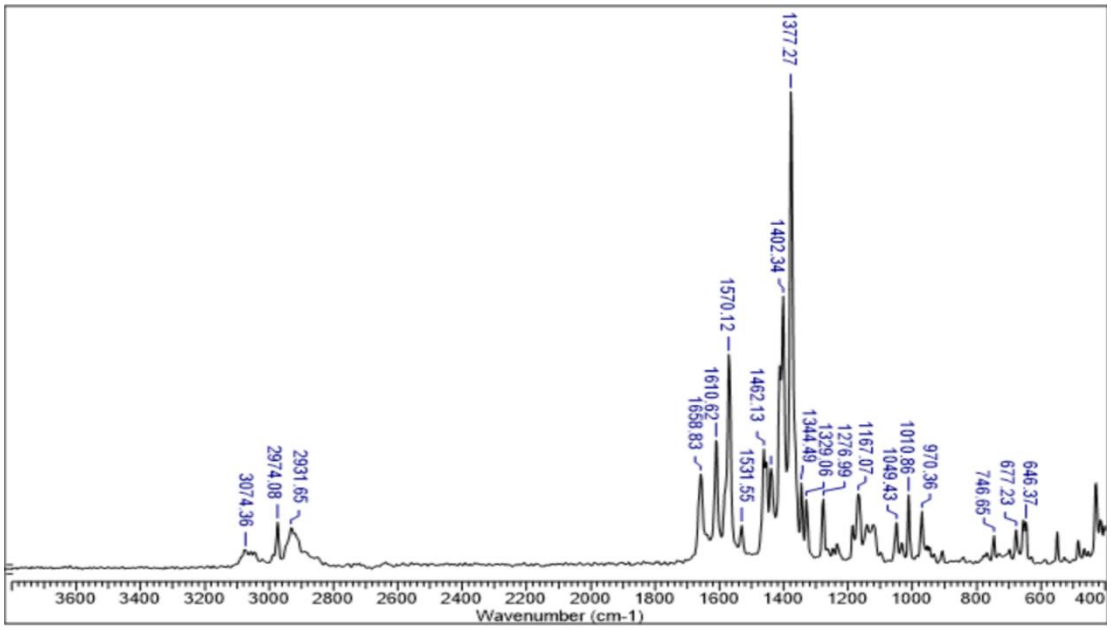

Figure S3. Experimental FT-Raman spectrum of compound **2**.

Theoretical Raman and infrared spectra of compound **2**

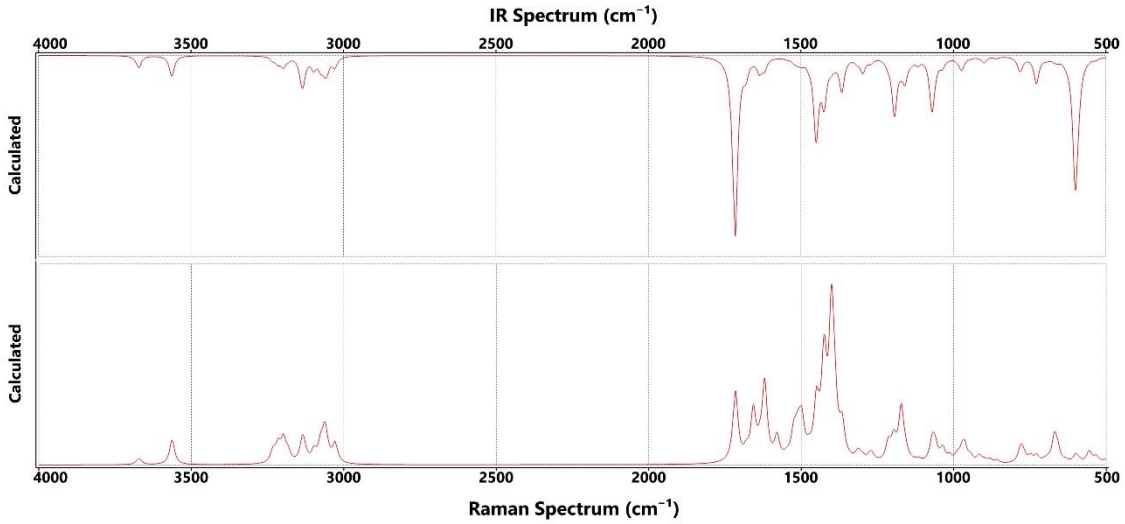

Figure S4. Theoretical Raman and infrared spectra of compound **2**.

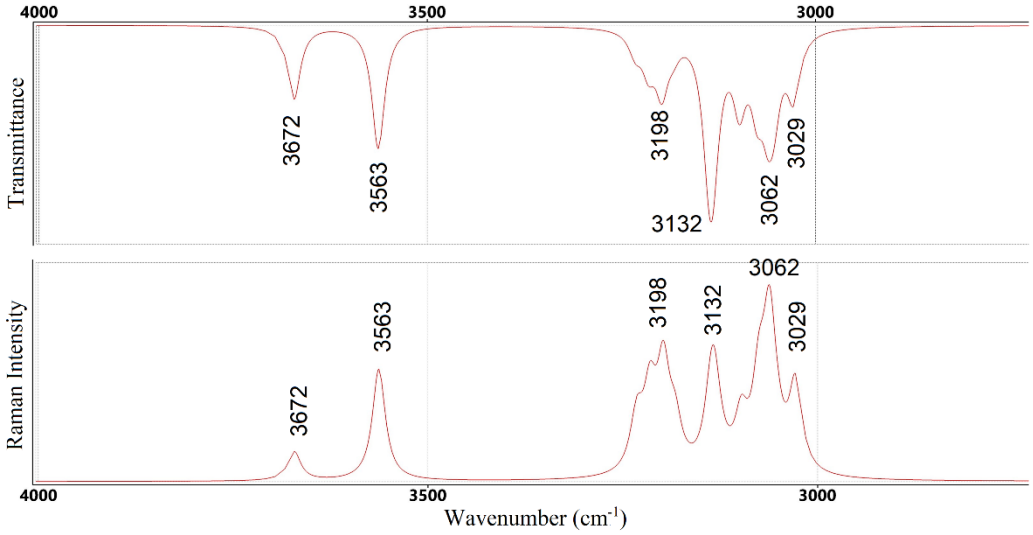

Figure S5. Expansion of theoretical Raman and infrared spectra in the region from 2750 to 4000 cm^{-1} of compound **2**.

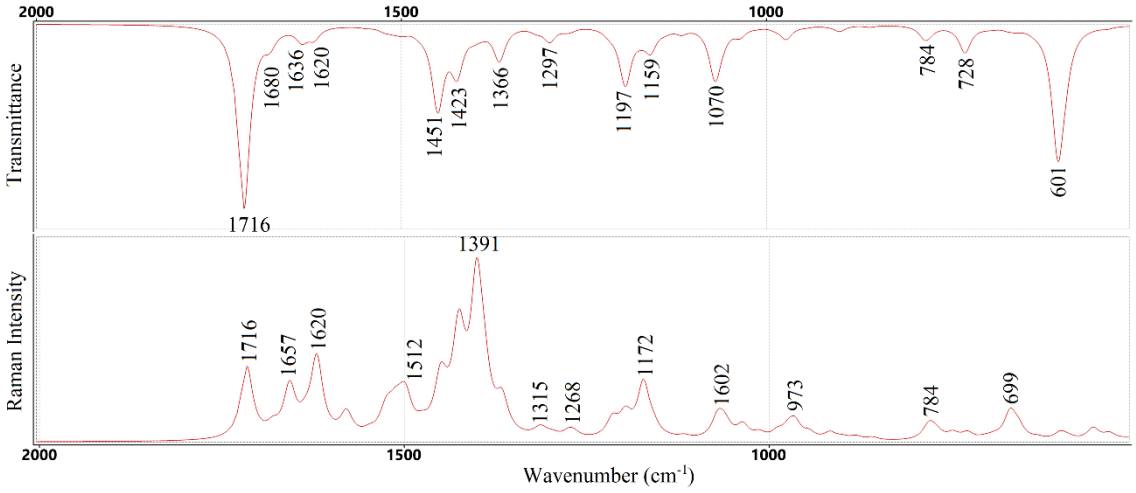

Figure S6. Expansion of theoretical Raman and infrared spectra in the region from 500 to 2000 cm^{-1} of compound **2**.

HRMS of compound **2**

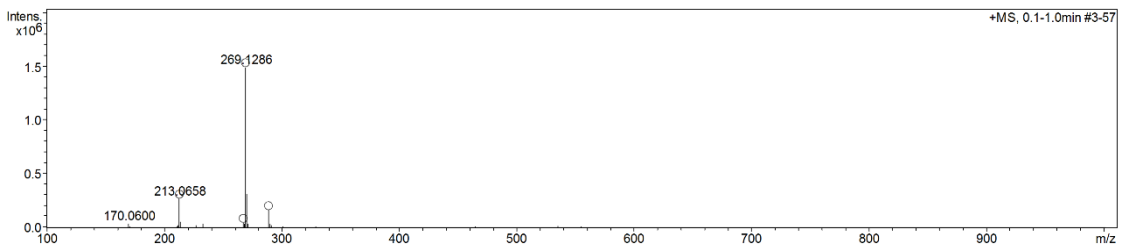

Figure S7. HRMS (TOF MS ESI+/MeOH-H_2O-0.1%-AcOH) of compound **2**.

Experimental NMR spectra of compound **2**

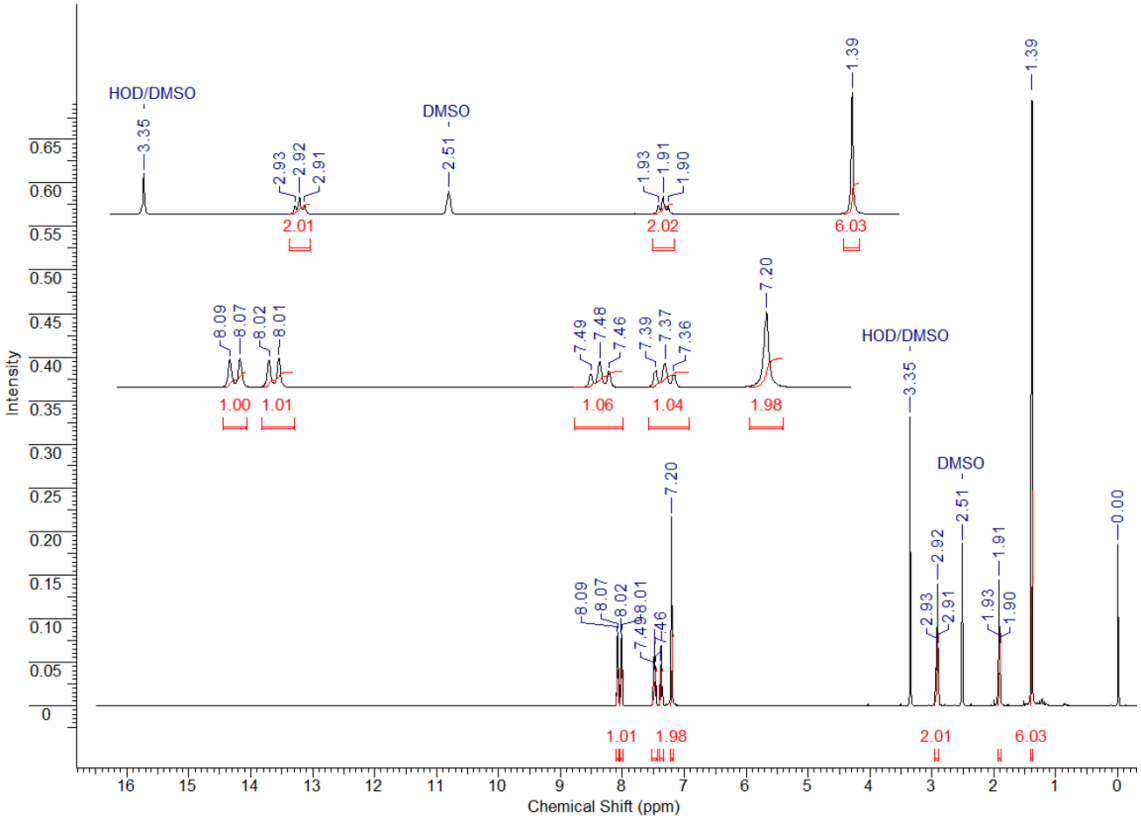

Figure S8. ^{1}H NMR (500 MHz, DMSO-d_6) spectrum of compound **2** and expansions of aromatic and aliphatic regions.

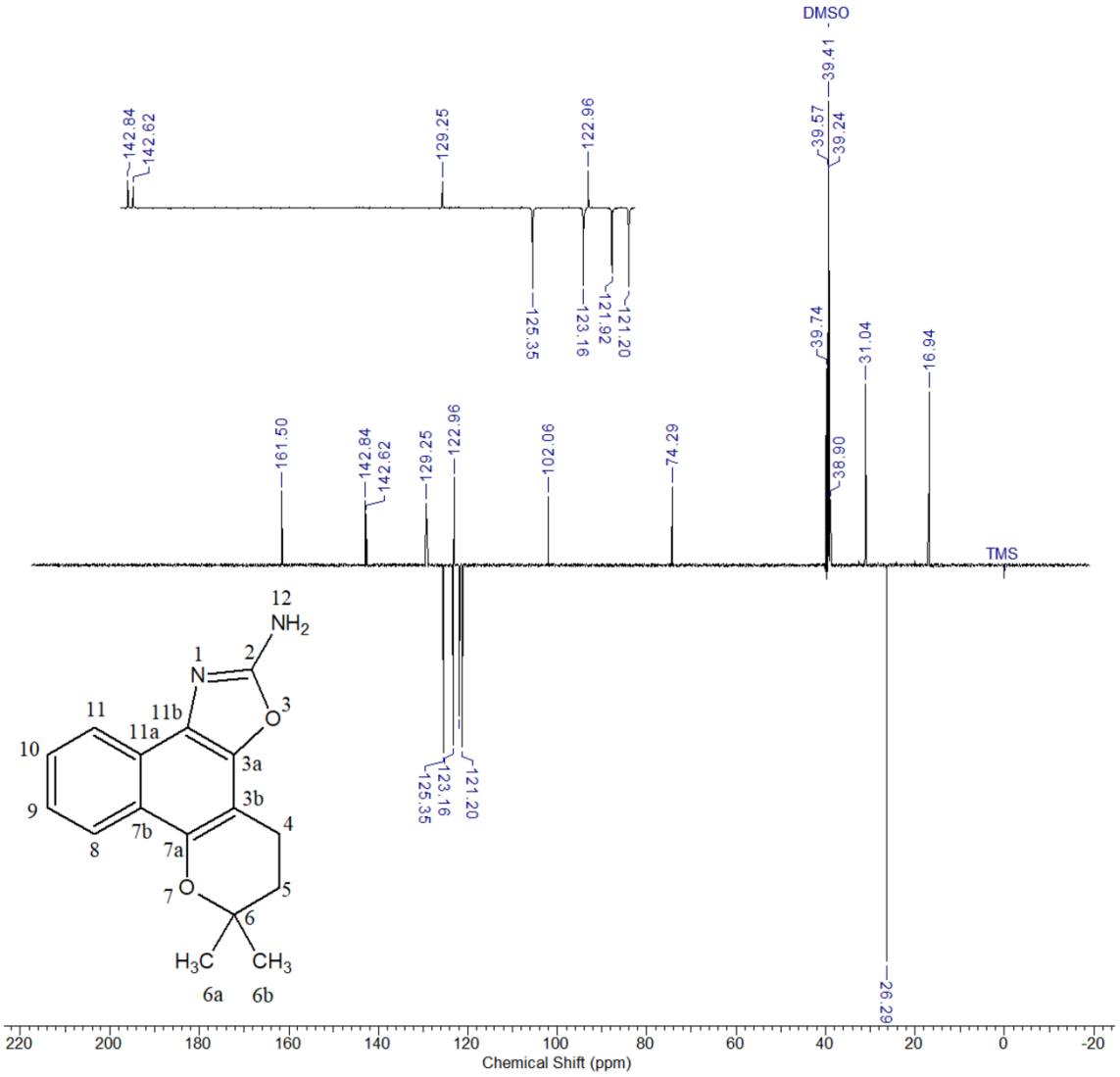

Figure S9. DEPTQ (125 MHz, DMSO-d_6) spectrum of compound **2** and expansion of aromatic region.

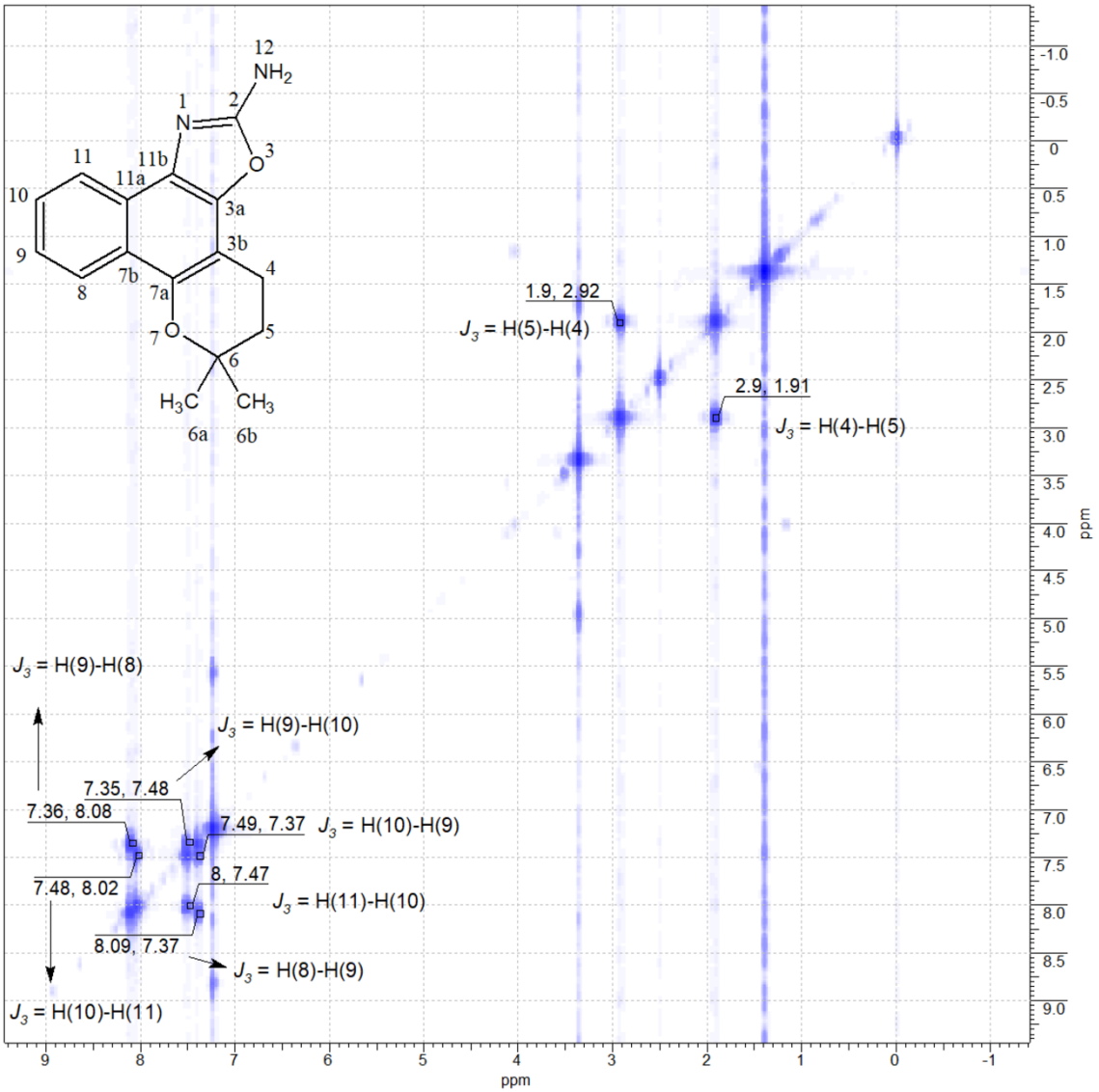

Figure S10. ^{1}H-HOMOCOSY (500 MHz, DMSO-d_6) spectrum of compound **2**.

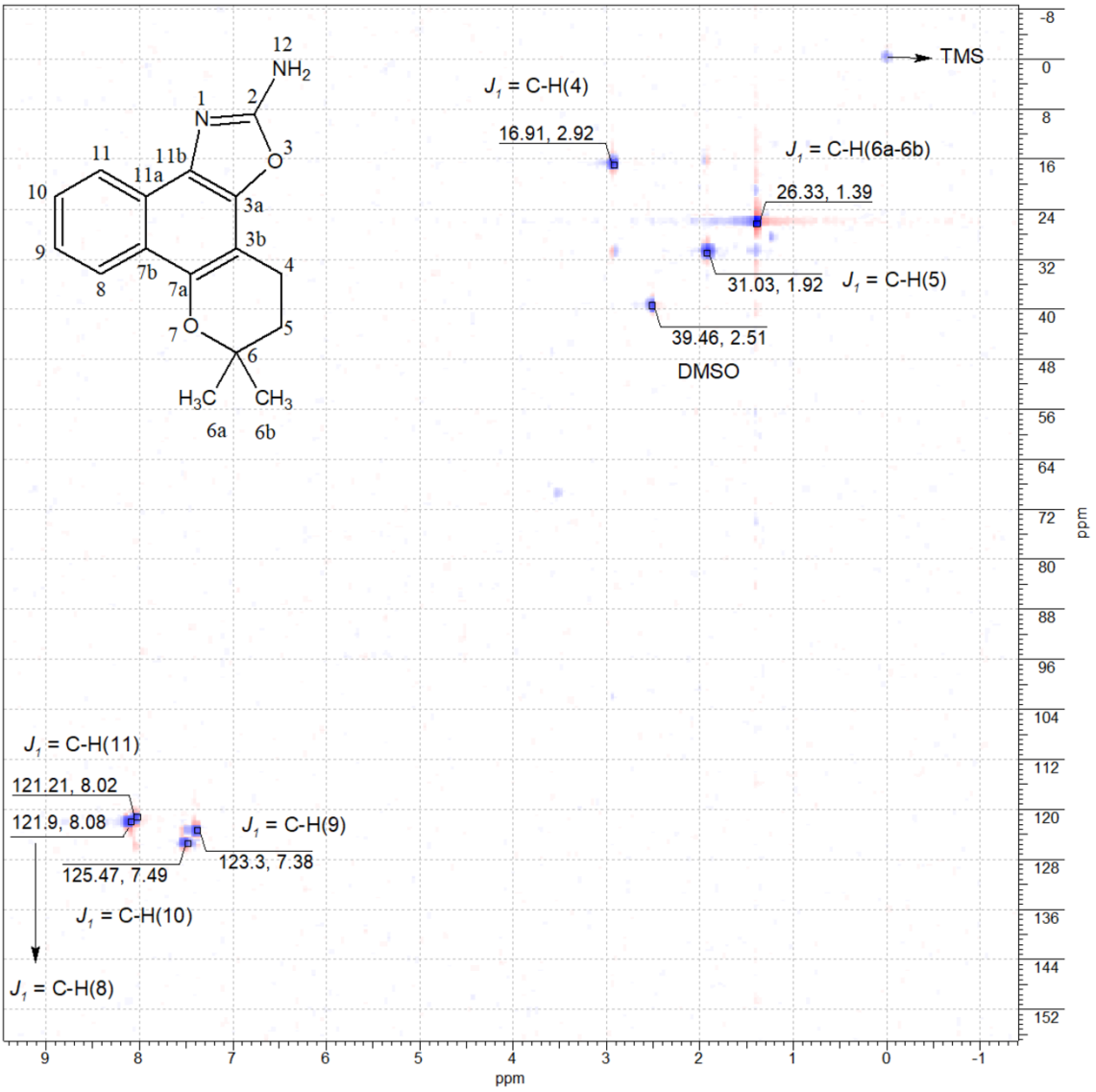

Figure S11. HSQC (125 MHz, DMSO-d_6) spectrum of compound **2**.

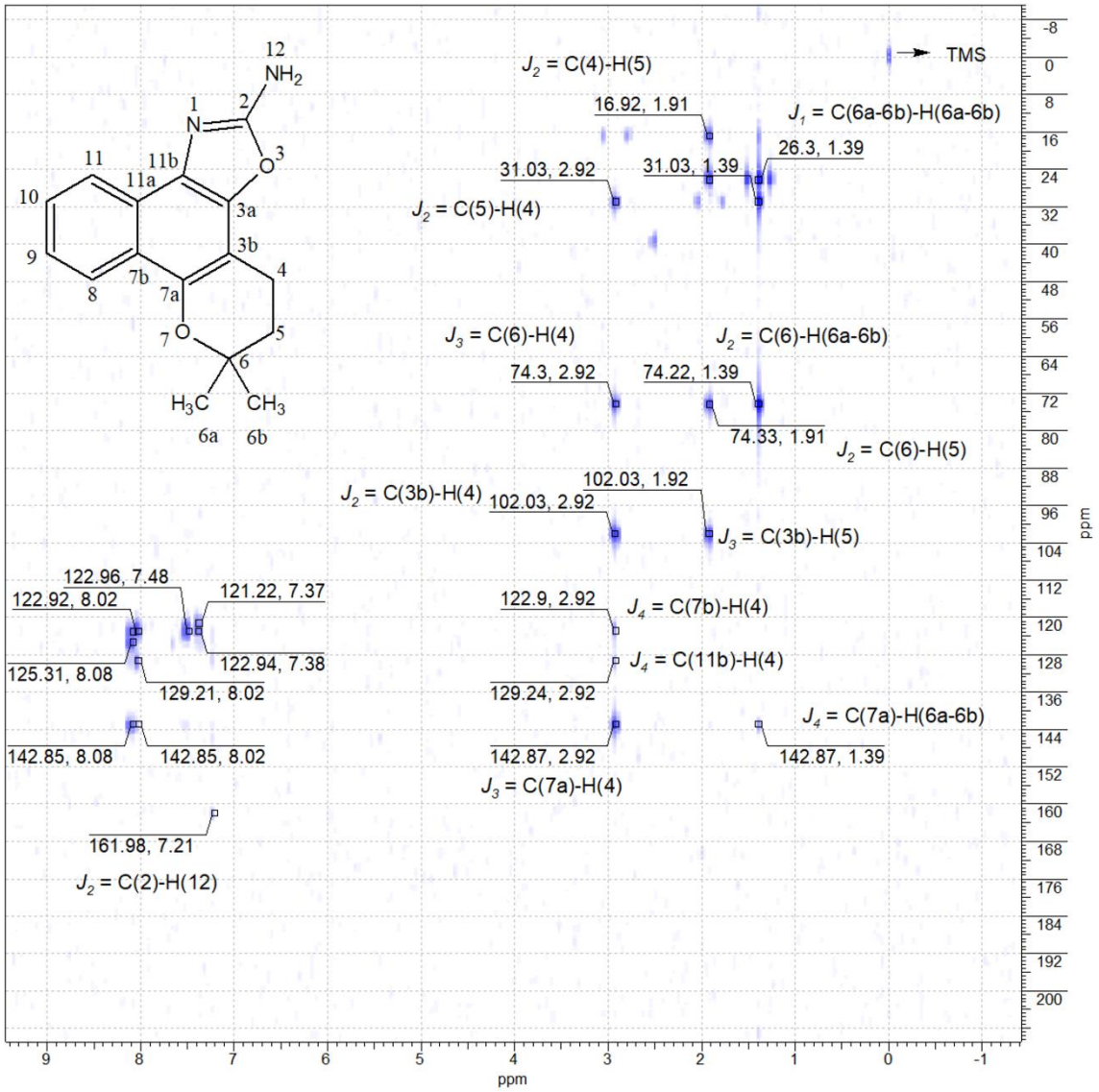

Figure S12. HMBC (125 MHz, DMSO-d_6) spectrum of compound **2**.

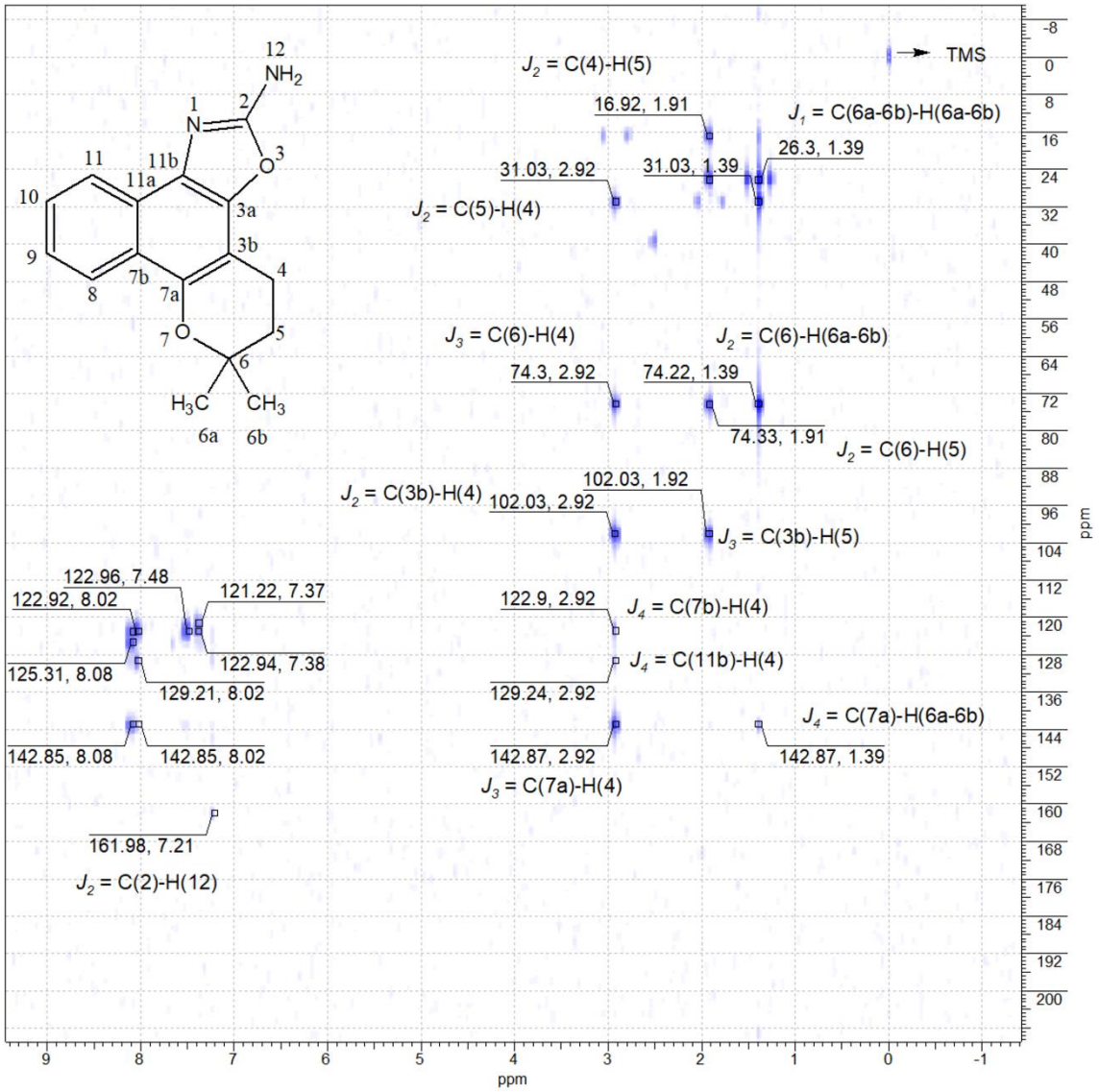

Figure S13. HMBC (125 MHz, DMSO-d_6) spectrum of compound **2**, expansion of the aromatic region.

Theoretical NMR spectra of compound **2**

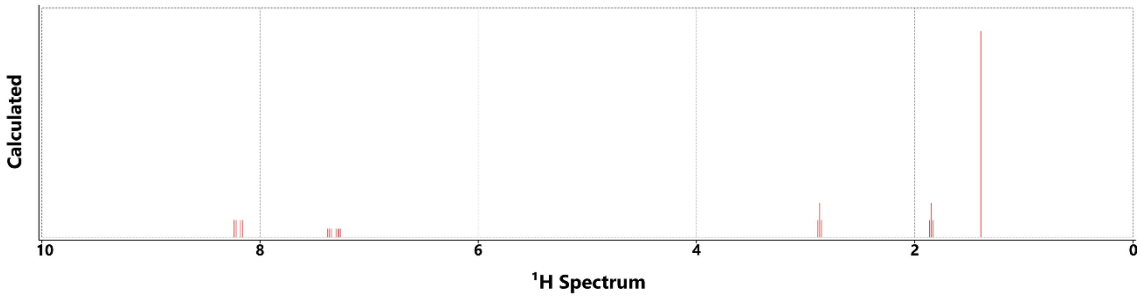

Figure S14. Theoretical ^{1}H NMR spectrum of compound **2**.

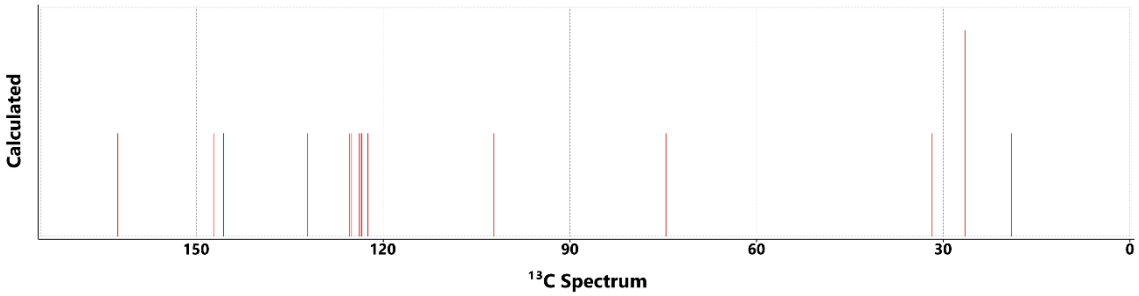

Figure S15. Theoretical ^{13}C NMR spectrum of compound **2**.

Experimental UV-Visible absorption spectrum of compound **2**

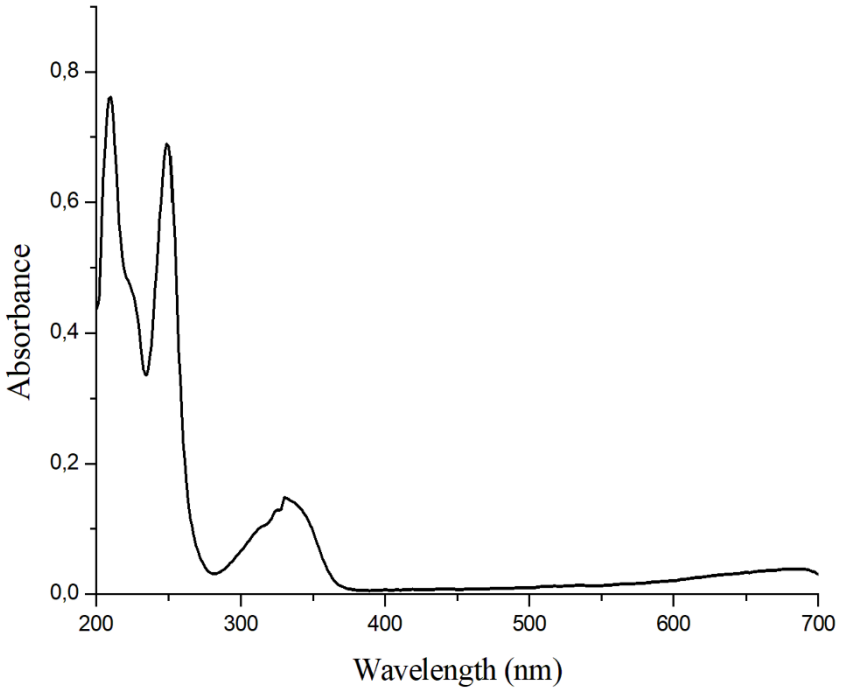

Figure S16. Experimental UV-Vis absorption spectrum of compound **2** (1.948×10^{-5} M) in methanol.

Theoretical UV-Visible absorption spectrum of compound **2**

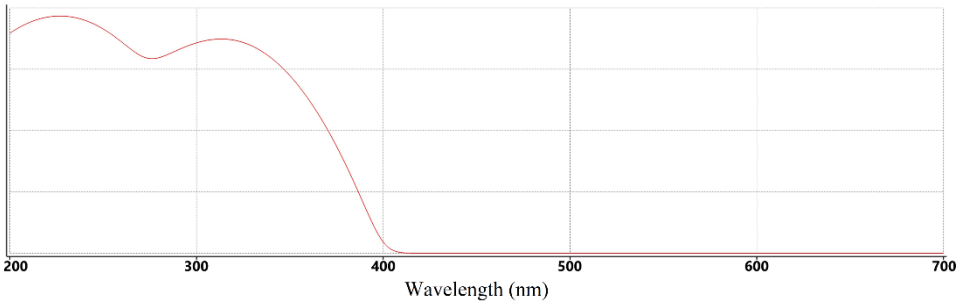

Figure S17. Theoretical UV-Vis absorption spectrum of compound **2**.

Spectroscopic UV-Visible absorption data

Table S1. Experimental and theoretical UV-Visible, band gap energy and oscillator strength of compound **2**

Experimental		Theoretical			
λ (ε / M^{-1} cm^{-1}) / nm	Band gap / eV	λ / nm	Band gap / eV	Oscillator strength	Assignment
330 (7,623)	3.757	316.64	3.915	0.1500	HOMO→LUMO (90%)
326[a]	3.803	294.29	4.213	0.0489	HOMO→LUMO+1 (71%) HOMO-1→LUMO (27%)
316[a]	3.923	238.35	5.201	0.1912	HOMO→LUMO+2 (77%)
249 (35,386)	4.979	225.88	5.488	0.3781	HOMO-2→LUMO+1 (29%) HOMO-1→LUMO (29%) HOMO-2→LUMO (15%) HOMO→LUMO+1 (13%)
224[a]	5.535	217.65	5.696	0.0556	HOMO→LUMO+3 (43%) HOMO-2→LUMO (25%)
210 (39,064)	5.904	210.19	5.898	0.0873	HOMO→LUMO+3 (45%) HOMO-2→LUMO (18%) HOMO→LUMO+4 (15%)

[a]These bands appear as shoulders. λ: wavelength; ε: molar absorption coefficient; HOMO: highest occupied molecular orbital; LUMO: lowest unoccupied molecular orbital.

Experimental emission spectrum of compound **2**

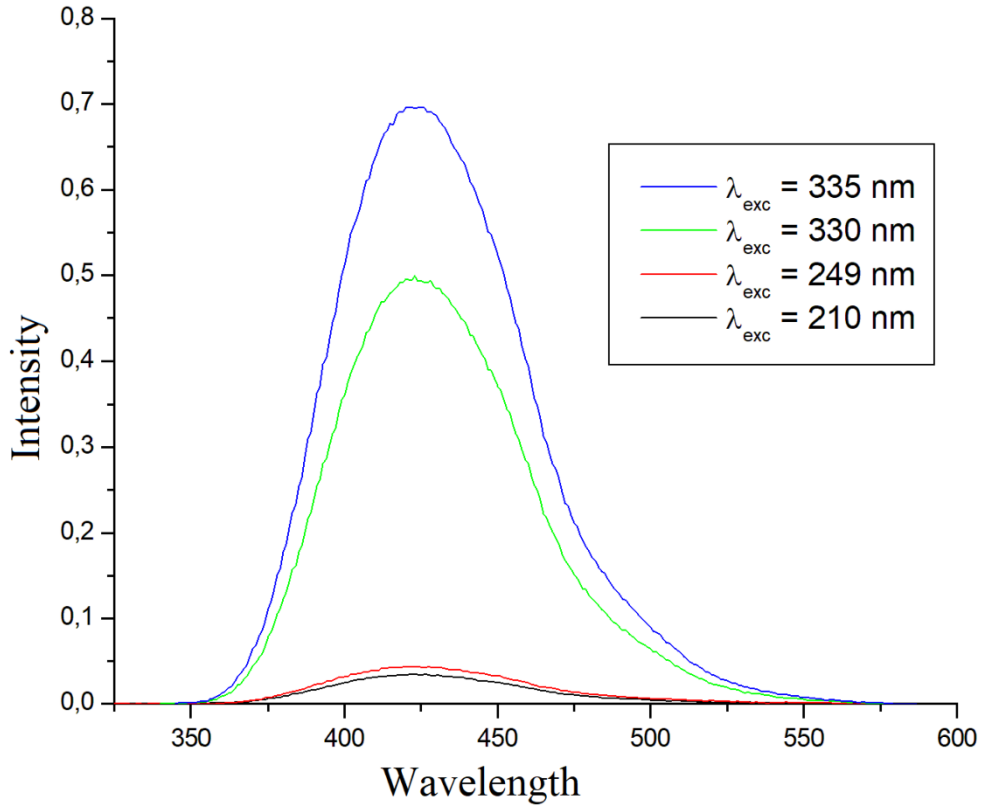

Figure S18. Experimental emission spectra of compound **2** (1.948×10^{-5} M) in methanol. The graphs represent the emission according the excitation at the absorption maximums and at 335 nm.

Spectroscopic data and physical properties data of compound **3**

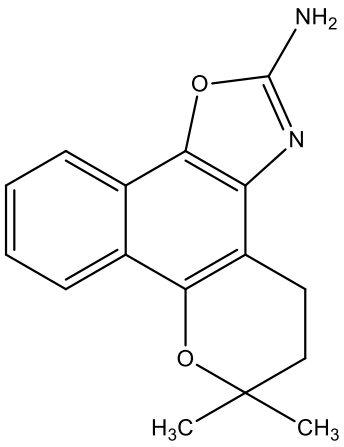

Figure S19. Chemical structure of 6,6-dimethyl-5,6-dihydro-4*H*-benzo[7,8]chromeno[5,6-*d*][1,3]oxazol-2-amine (compound **3**).

6,6-Dimethyl-5,6-dihydro-4*H*-benzo[7,8]chromeno[6,5-*d*][1,3]oxazol-2-amine (**3**)

mp not determined; ^{1}H NMR (400 MHz, DMSO-d_6) δ 1.38 (s, 6H, $CH_3 \times 2$), 1.89 (t, 2H, *J* 6.78 Hz, CH_2), 2.88 (t, 2H, *J* 6.65 Hz, CH_2), 7.29 (t, 1H, *J* 7.03 Hz, CH), 7.39 (s, 2H, NH_2), 7.48 (t, 1H, *J* 7.03 Hz, CH), 7.76 (d, 1H, *J* 8.28 Hz, CH), 8.07 (d, 1H, *J* 8.53 Hz, CH); ^{13}C NMR (100 MHz, DMSO-d_6) δ 18.5, 26.9, 31.9, 74.7, 107.1, 118.2, 118.4, 120.4, 122.5, 122.8, 126.7, 134.8, 139.5, 145.3, 163.3; HRMS (TOF MS ESI+, MeOH-H_2O-0.1%-AcOH) *m/z*, calcd. for $C_{16}H_{17}N_2O_2$ $[M + H]^+$: 269.1285; found: 269.1295.

HRMS of compound **3**

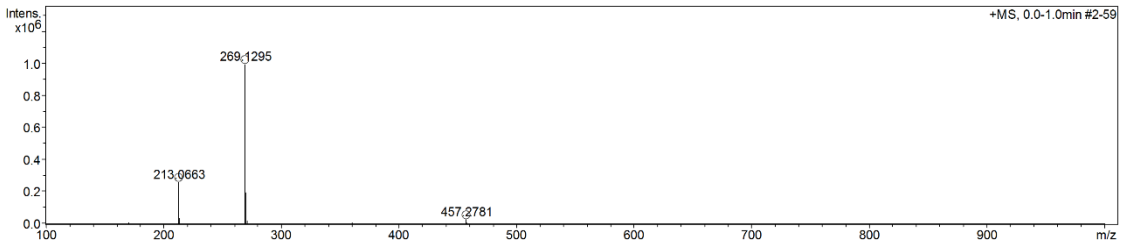

Figure S20. HRMS (TOF MS ESI+/MeOH-H_2O-0.1%-AcOH) spectrum of compound **3**.

NMR spectra of compound **3**

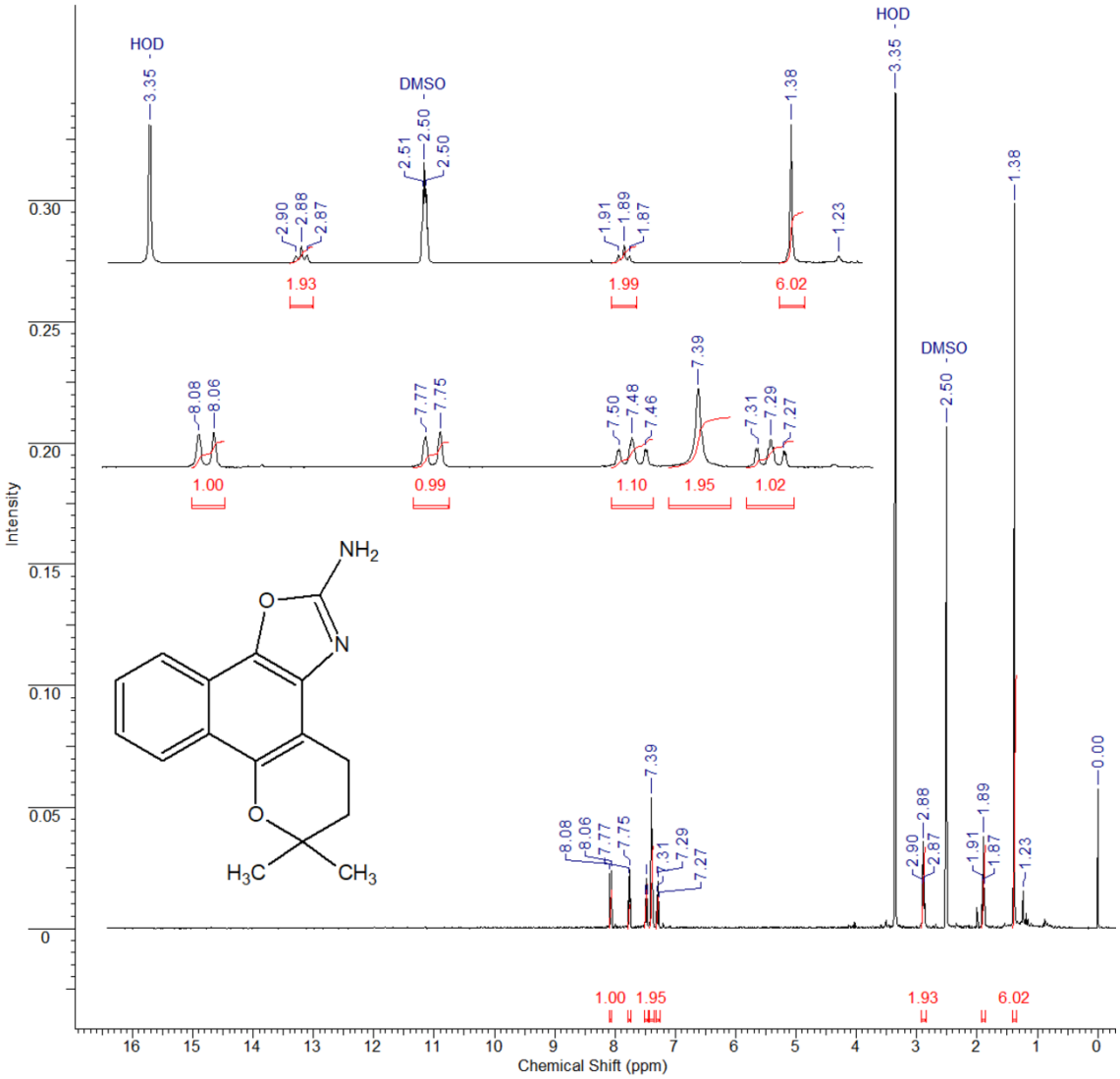

Figure S21. ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **3** and expansions of aromatic and aliphatic regions.

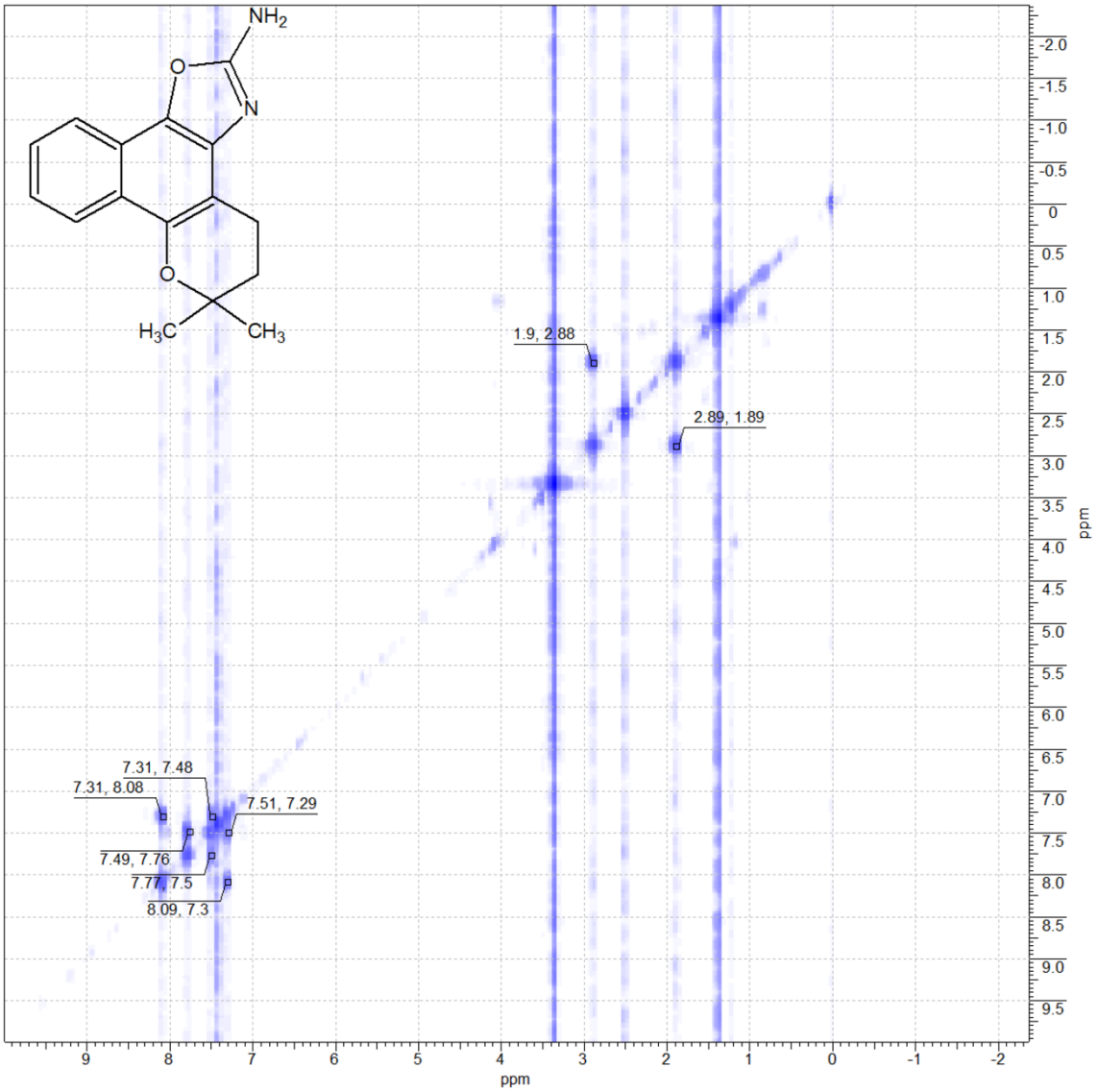

Figure S22. ^{1}H-HOMOCOSY (400 MHz, DMSO-d_6) spectrum of compound **3**.

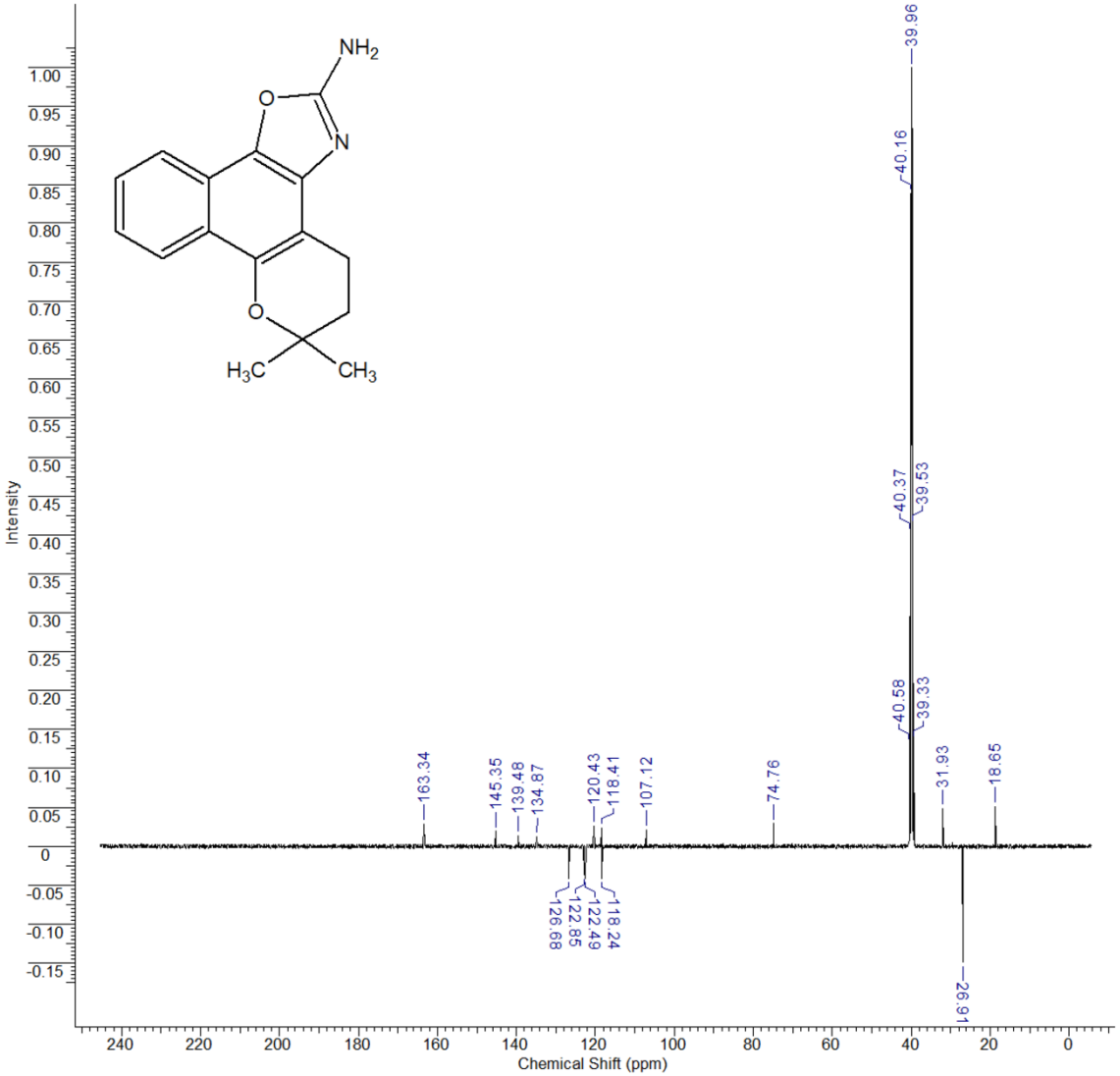

Figure S23. DEPTQ (100 MHz, DMSO-d_6) spectrum of compound **3**.

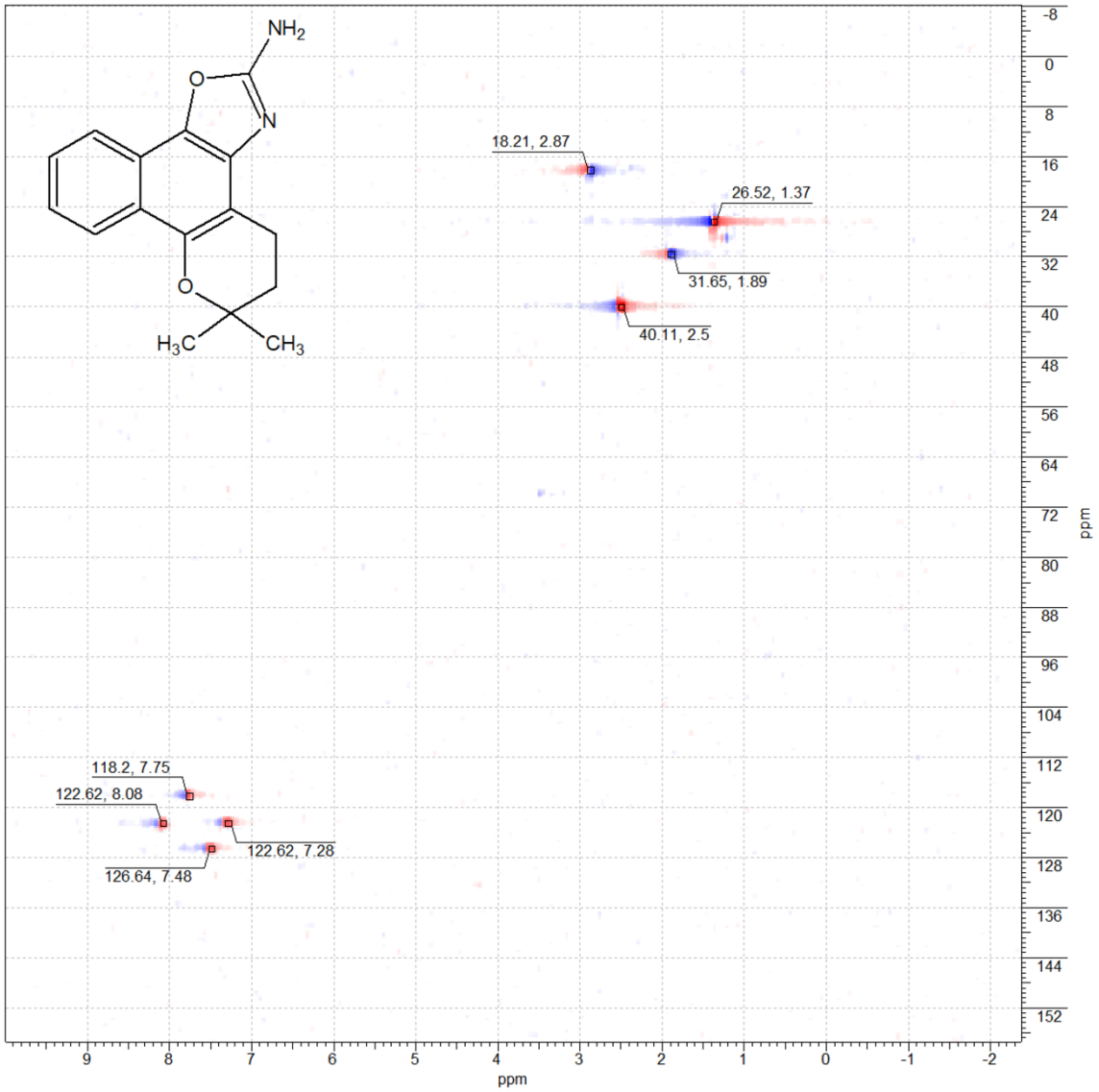

Figure S24. HSQC (100 MHz, DMSO-d_6) spectrum of compound **3**.

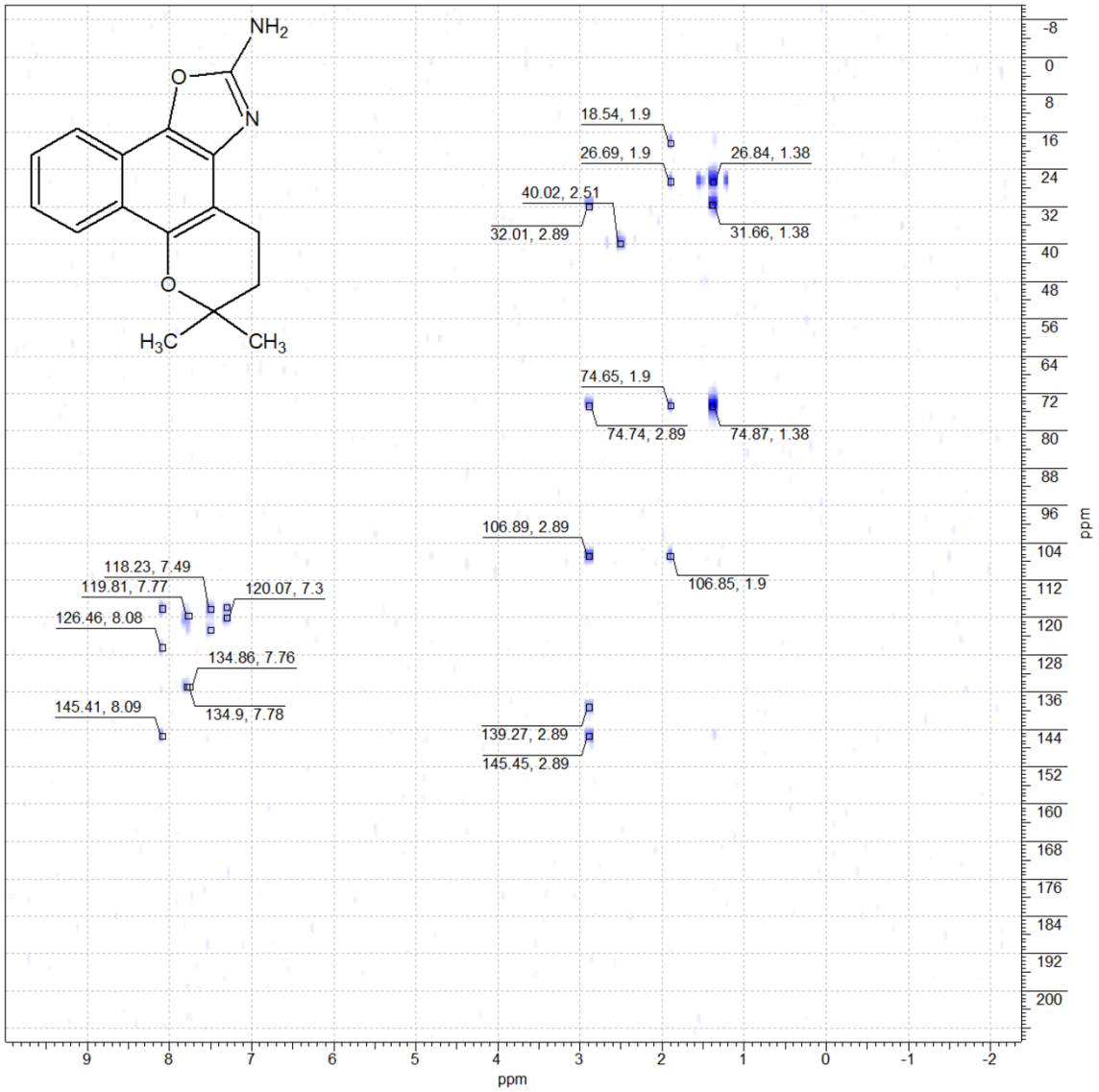

Figure S25. HMBC (100 MHz, DMSO-d_6) spectrum of compound **3**.

Enthalpies of formation of the reagents, intermediaries and products

The calculations indicate that the regioselectivity is not related to the difference between the ΔH_{form} of compounds **2** and **3**, which is much smaller (Δ = 0.956 kJ mol^{-1}). But the ΔH_{form} of the intermediate **4** (precursor of **2**) is 16.884 kJ mol^{-1} lower than that of intermediate **6** (precursor of **3**). For intermediaries **5** and **7**, the order is maintained, and the difference is 7.140 kJ mol^{-1}.

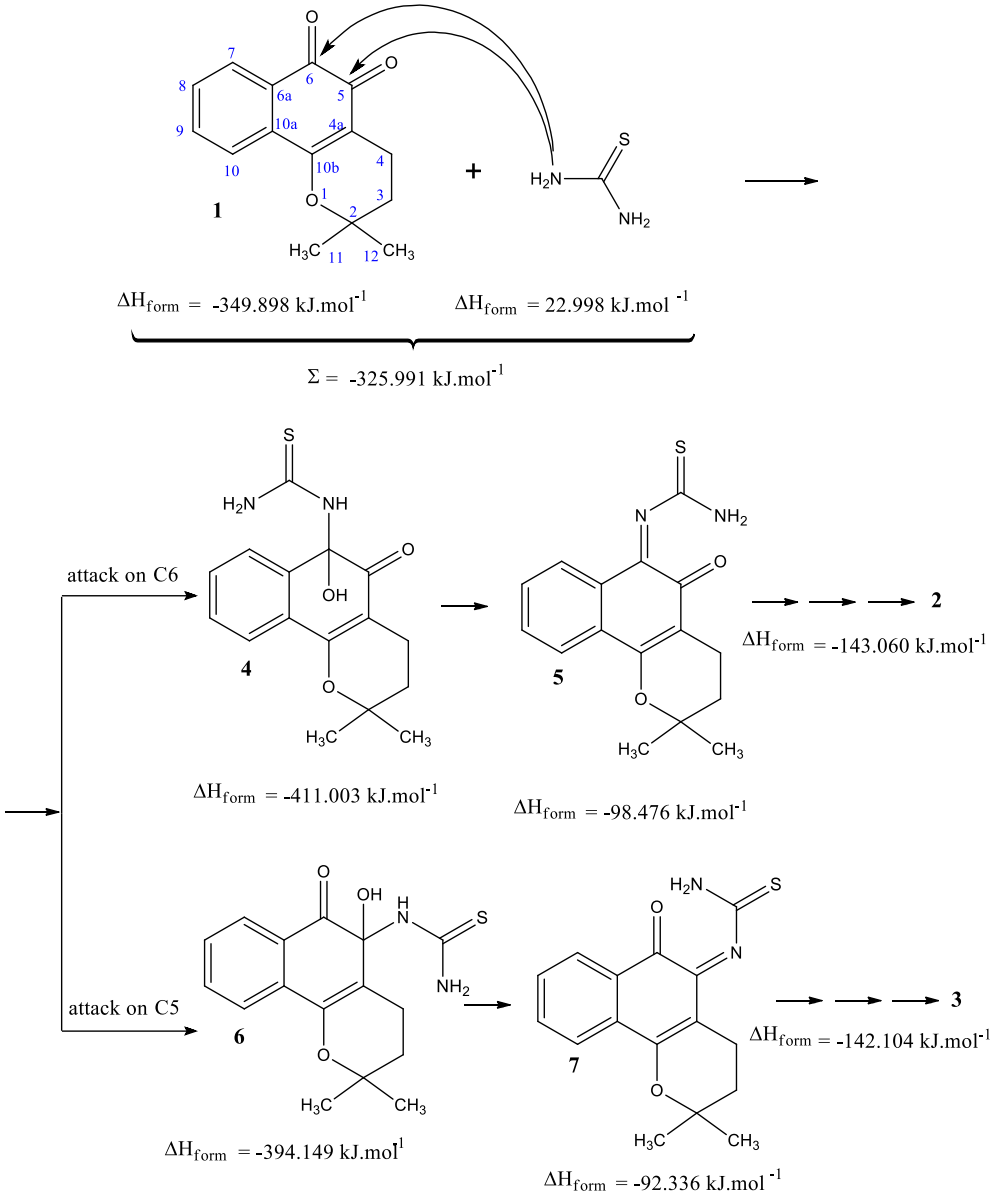

Figure S26. Initial steps of the reaction between β-lapachone and thiourea, including the enthalpies of formation (ΔH_{form}) of each species included.

checkCIF/PLATON report

Structure factors have been supplied for datablock(s) BLO2NH2

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found. CIF dictionary Interpreting this report

Datablock: BLO2NH2

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Bond precision:  C-C = 0.0035 A          Wavelength=0.71073

Cell:          a=5.8593(13)       b=10.810(3)      c=11.415(3)
               alpha=108.432(8)   beta=90.466(7)   gamma=98.891(7)
Temperature:   298 K
```

	Calculated	Reported
Volume	676.4(3)	676.4(3)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C16 H16 N2 O2	C16 H16 N2 O2
Sum formula	C16 H16 N2 O2	C16 H16 N2 O2
Mr	268.31	268.31
Dx,g cm-3	1.317	1.317
Z	2	2
Mu (mm-1)	0.088	0.088
F000	284.0	284.0
F000'	284.12	
h,k,lmax	7,13,13	7,13,13
Nref	2580	2580
Tmin,Tmax	0.967,0.990	0.682,0.745
Tmin'	0.956	

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Correction method= # Reported T Limits: Tmin=0.682 Tmax=0.745
AbsCorr = MULTI-SCAN

Data completeness= 1.000          Theta(max)= 25.766

R(reflections)= 0.0577( 1783)     wR2(reflections)= 0.1770( 2558)

S = 1.044                  Npar= 191
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The following ALERTS were generated. Each ALERT has the format
test-name_ALERT_alert-type_alert-level.
Click on the hyperlinks for more details of the test.

Alert level C

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PLAT094_ALERT_2_C Ratio of Maximum / Minimum Residual Density ....       2.07 Report
PLAT242_ALERT_2_C Low    'MainMol' Ueq as Compared to Neighbors of         C6 Check
PLAT420_ALERT_2_C D-H Without Acceptor       N2       --H2B      .     Please Check
PLAT911_ALERT_3_C Missing FCF Refl Between Thmin & STh/L=    0.600          9 Report
PLAT913_ALERT_3_C Missing # of Very Strong Reflections in FCF ....          4 Note
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Alert level G

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PLAT398_ALERT_2_G Deviating  C-O-C    Angle From 120 for O3            103.3 Degree
PLAT720_ALERT_4_G Number of Unusual/Non-Standard Labels .........          6 Note
PLAT910_ALERT_3_G Missing # of FCF Reflection(s) Below Theta(Min).         2 Note
PLAT912_ALERT_4_G Missing # of FCF Reflections Above STh/L=  0.600        11 Note
PLAT941_ALERT_3_G Average HKL Measurement Multiplicity .........         4.3 Low
PLAT978_ALERT_2_G Number C-C Bonds with Positive Residual Density.         5 Info
```

```
  0 ALERT level A = Most likely a serious problem - resolve or explain
  0 ALERT level B = A potentially serious problem, consider carefully
  5 ALERT level C = Check. Ensure it is not caused by an omission or oversight
  6 ALERT level G = General information/check it is not something unexpected

  0 ALERT type 1 CIF construction/syntax error, inconsistent or missing data
  5 ALERT type 2 Indicator that the structure model may be wrong or deficient
  4 ALERT type 3 Indicator that the structure quality may be low
  2 ALERT type 4 Improvement, methodology, query or suggestion
  0 ALERT type 5 Informative message, check
```

It is advisable to attempt to resolve as many as possible of the alerts in all categories. Often the minor alerts point to easily fixed oversights, errors and omissions in your CIF or refinement strategy, so attention to these fine details can be worthwhile. In order to resolve some of the more serious problems it may be necessary to carry out additional measurements or structure refinements. However, the purpose of your study may justify the reported deviations and the more serious of these should normally be commented upon in the discussion or experimental section of a paper or in the "special_details" fields of the CIF. checkCIF was carefully designed to identify outliers and unusual parameters, but every test has its limitations and alerts that are not important in a particular case may appear. Conversely, the absence of alerts does not guarantee there are no aspects of the results needing attention. It is up to the individual to critically assess their own results and, if necessary, seek expert advice.

Publication of your CIF in IUCr journals

A basic structural check has been run on your CIF. These basic checks will be run on all CIFs submitted for publication in IUCr journals (*Acta Crystallographica*, *Journal of Applied Crystallography*, *Journal of Synchrotron Radiation*); however, if you intend to submit to *Acta Crystallographica Section C* or *E* or *IUCrData*, you should make sure that full publication checks are run on the final version of your CIF prior to submission.

Publication of your CIF in other journals

Please refer to the *Notes for Authors* of the relevant journal for any special instructions relating to CIF submission.

PLATON version of 10/08/2020; check.def file version of 06/08/2020

Datablock BLO2NH2 - ellipsoid plot