No. 79 LABORATORY SPECTRA FOR TESTING THE PRESENCE OF MINOR CONSTITUENTS IN PLANETARY ATMOSPHERES, II: C_2H_2, C_2H_4, C_2H_6, CH_3SH, CH_3NH_2, H_2S

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This is the second of two papers presenting laboratory observations of small amounts of various gases that may occur in the atmospheres of the planets. In this paper are spectra of several hydrocarbons and H_2S in the spectral region of the lead sulfide detector (1.0–2.6 microns). The observations were made with the same scanning spectrometer (described by Kuiper, *et al.* 1962) that was used for the spectra in Paper I of this series (Kuiper and Cruikshank 1964). The information on the laboratory apparatus given here also applies to Paper I.

The absorption cells used in the laboratory were all single-pass tubes made of glass or, for non-corrosive gases, galvanized iron. Windows of glass or Suprasil (Englehard Industries, Inc.) were used, as well as glass lenses. An incandescent laboratory lamp was used for illumination. The spectrum was scanned at three different rates. For an initial reconnaissance, a scan was made in two increments (1.0–1.9 microns and 1.9–2.6 microns) at a rate of 5/1, which corresponds to 7.5 Å per sec and 495 Å per in. on the original records. The two spectral regions were then traced at a scan rate of 12.5/1 corresponding to 3 Å per sec and 198 Å per in. on the original records. For spectral regions containing bands of particular interest, higher resolution tracings were made with a scan rate of 25/1, corresponding to 1.5 Å per sec and 99 Å per in. on the original records. The time constant was one second in all cases. The lead sulfide detector was 0.1 × 2.5 mm in dimension. The spectrometer slit was 0.18 mm wide. A grating with 600 lines per millimeter and blazed for 1.6 microns first order was used. In the spectral range 1.0–1.9 microns a Corning 2540 filter was used, and in the range 1.9–2.6 microns, a Bausch and Lomb interference filter.

Assignments were recorded only for C_2H_2 (Herzberg 1945, p. 290). Extensive references listed by Herzberg give additional information on band assignments.

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REFERENCES

Kuiper, G. P., and Cruikshank, D. P. 1964, "Laboratory Spectra for Testing the Presence of Minor Constituents in Planetary Atmospheres, I: CH_4, NH_3, N_2O, CO, COS, Region 1–2.5 μ," *Comm. LPL*, 2, 141–165.

Kuiper, G. P., Goranson, R., Binder, A., and Johnson, H. L. 1962, "An Infrared Stellar Spectrometer," *Comm. LPL*, 1, 119–127.

Herzberg, G. 1945, *Molecular Spectra and Molecular Structure, II, Infrared and Raman Spectra of Polyatomic Molecules* (Princeton: D. Van Nostrand Co.).

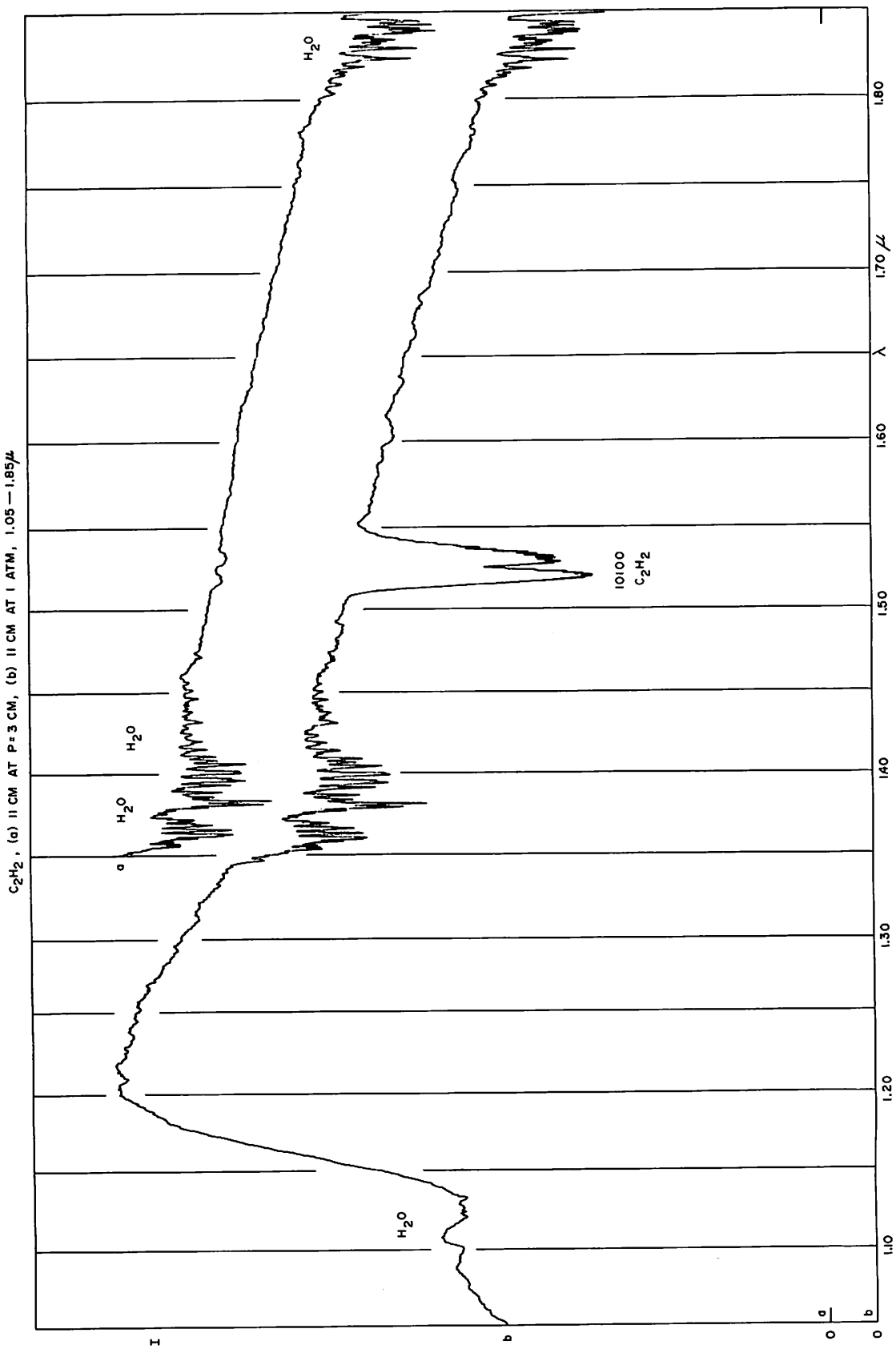

C_2H_2, (a) 11 CM AT P=3 CM, (b) 11 CM AT 1 ATM, 1.05—1.85μ
H_2O
H_2O
H_2O
H_2O
H_2O
10100
C_2H_2
a
b
I
0
0
a
b
1.10
1.20
1.30
1.40
1.50
1.60
1.70 μ
λ
1.80

Fig. 1

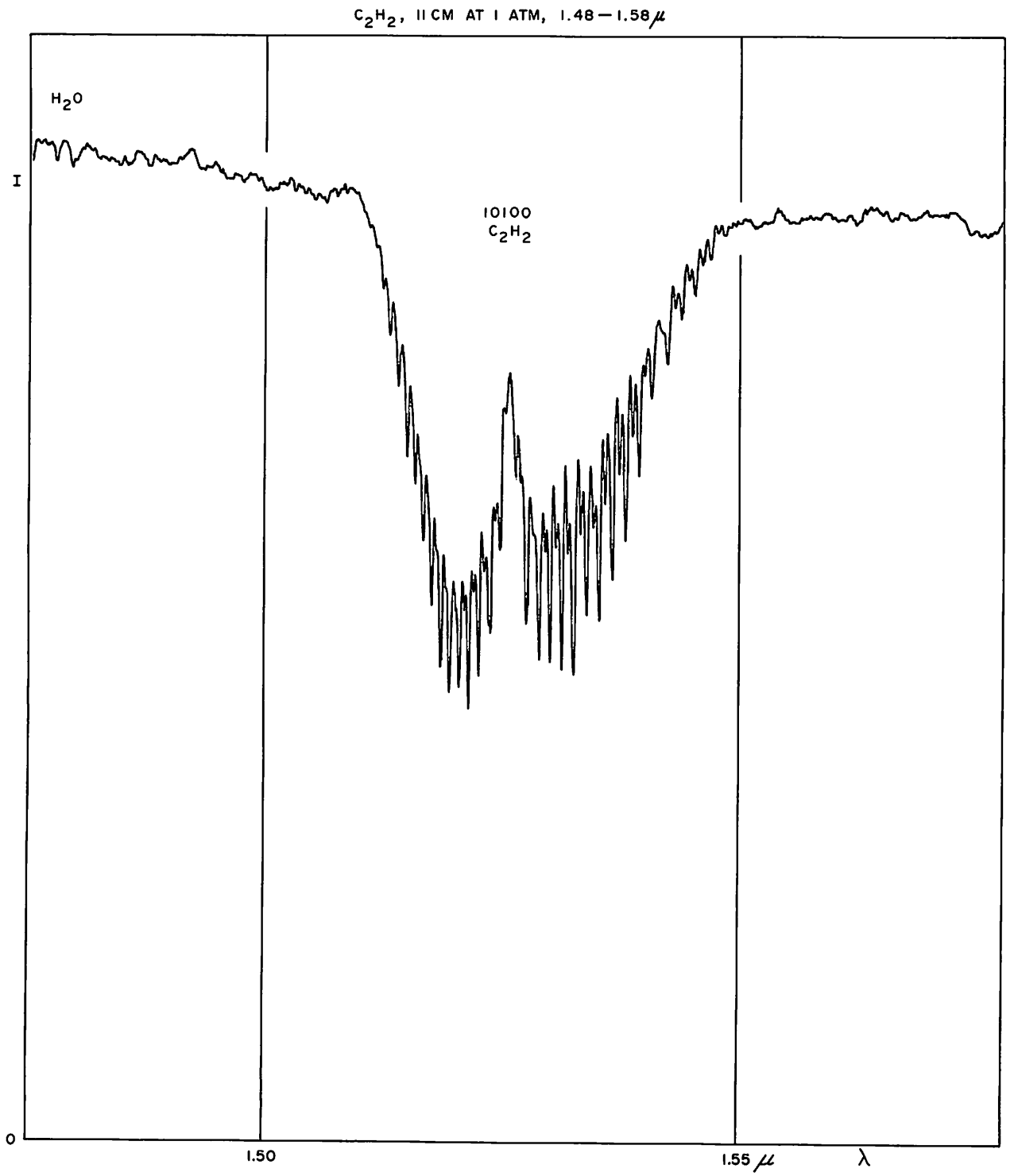


Fig. 2

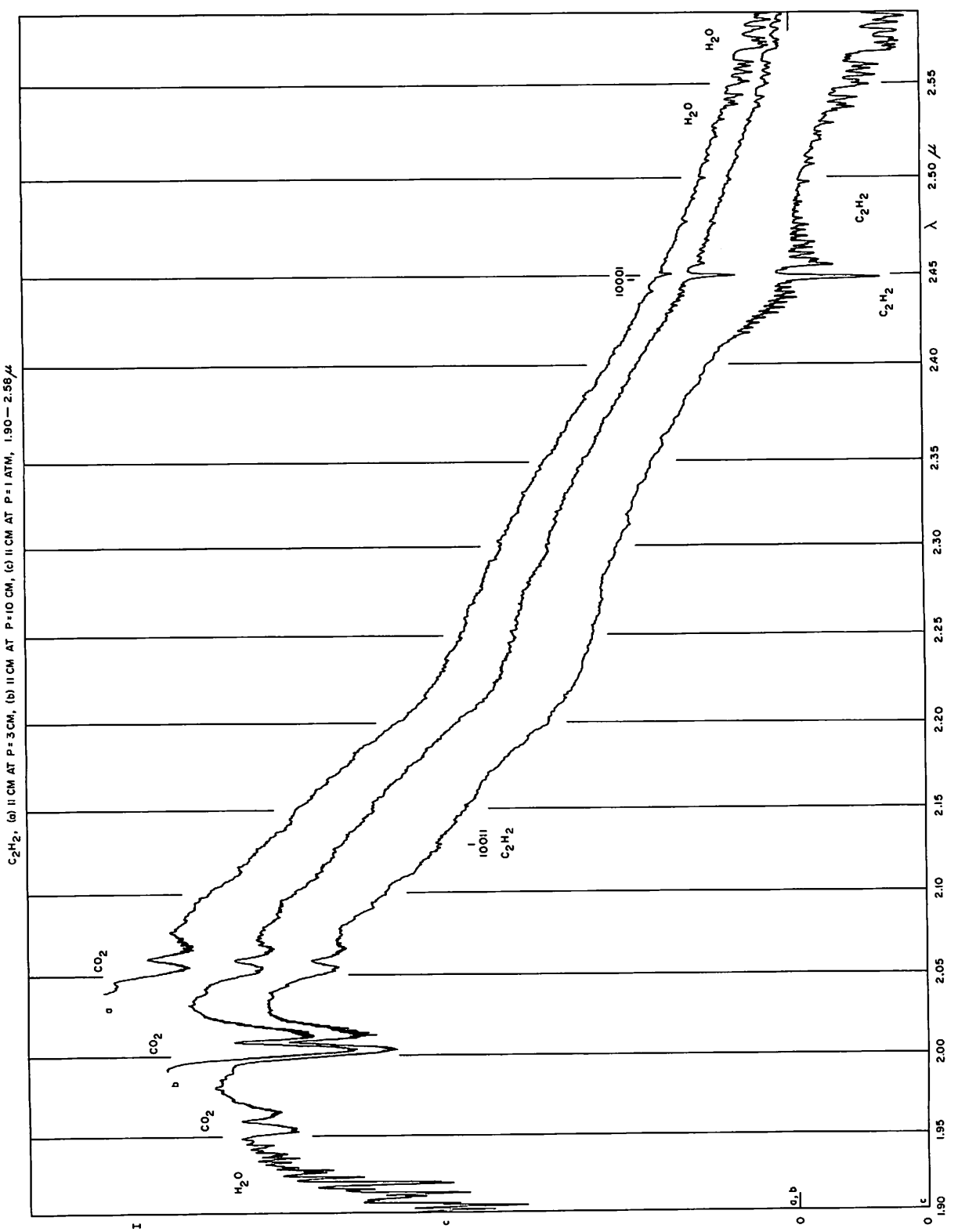

C2H2, (a) 11 CM AT P=3 CM, (b) 11 CM AT P=10 CM, (c) 11 CM AT P=1 ATM, 1.90—2.58 μ
CO2
CO2
CO2
H2O
H2O
H2O
10001
10011
C2H2
C2H2
C2H2
a
b
c
a,b
I
λ
2.50 μ
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.55

Fig. 3

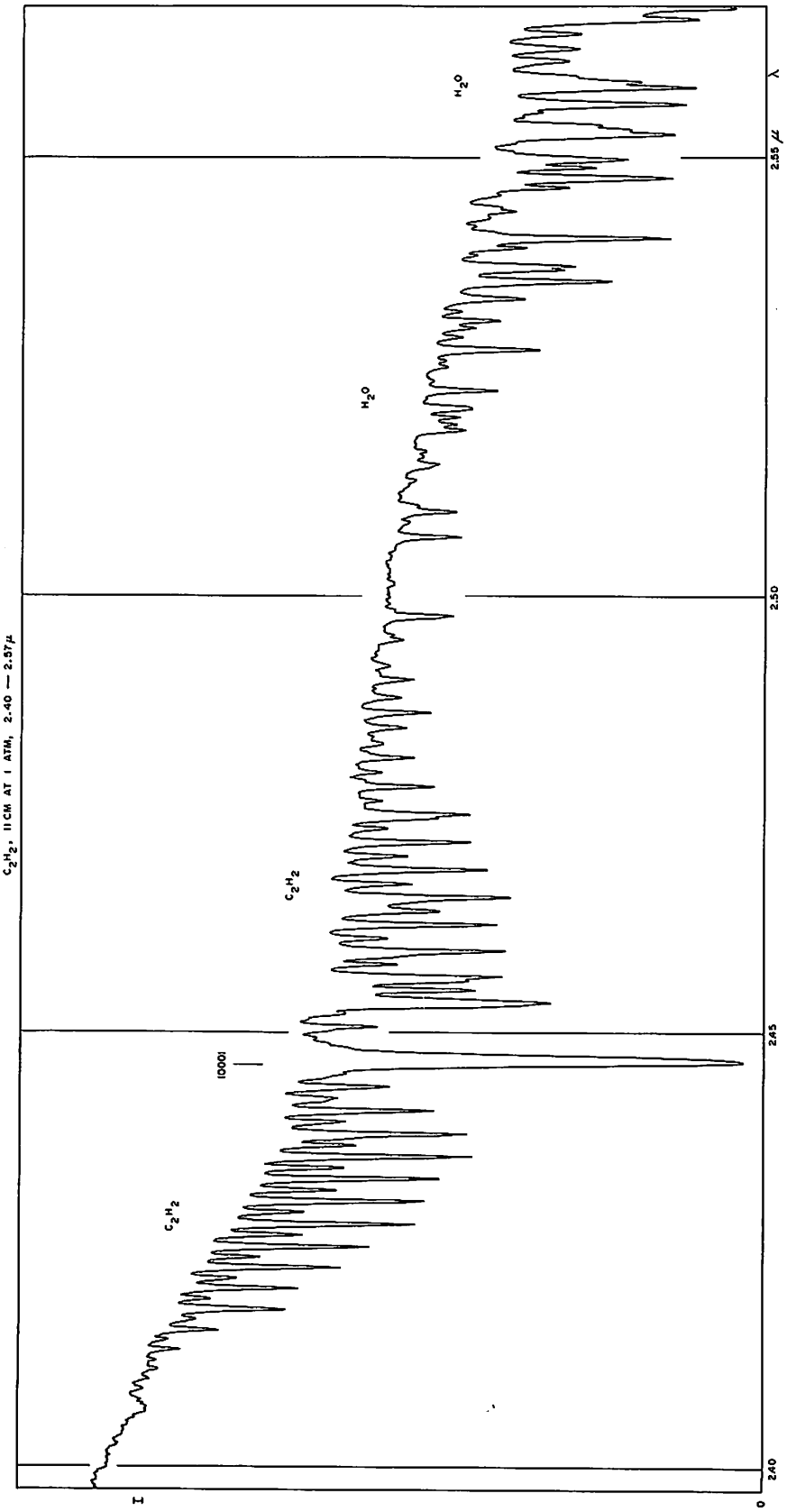

C_2H_2, 11 CM AT 1 ATM, 2.40 — 2.57 μ
I
0
2.40
2.45
2.50
2.55 μ
λ
C_2H_2
1000
C_2H_2
H_2O
H_2O

Fig. 4

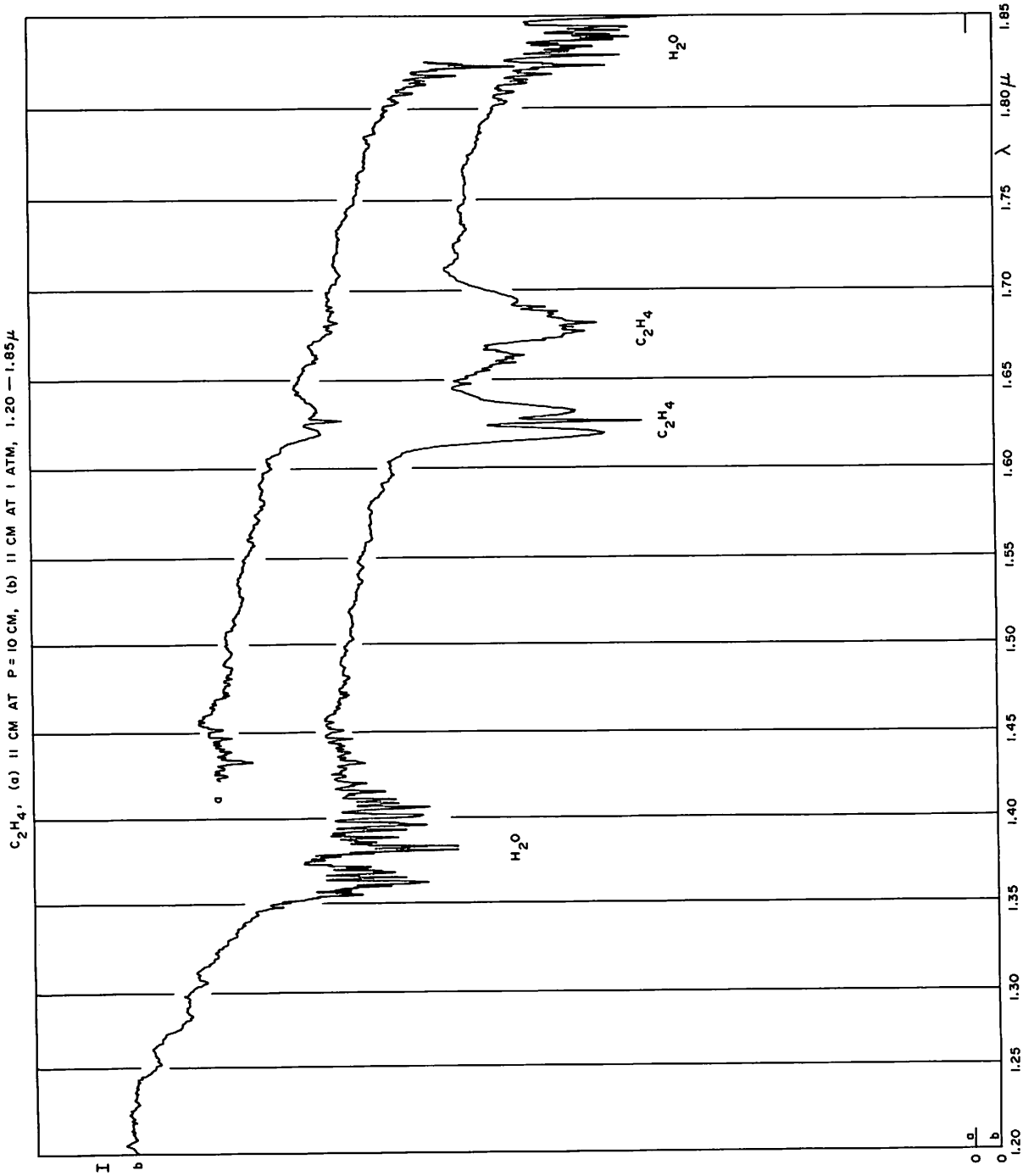
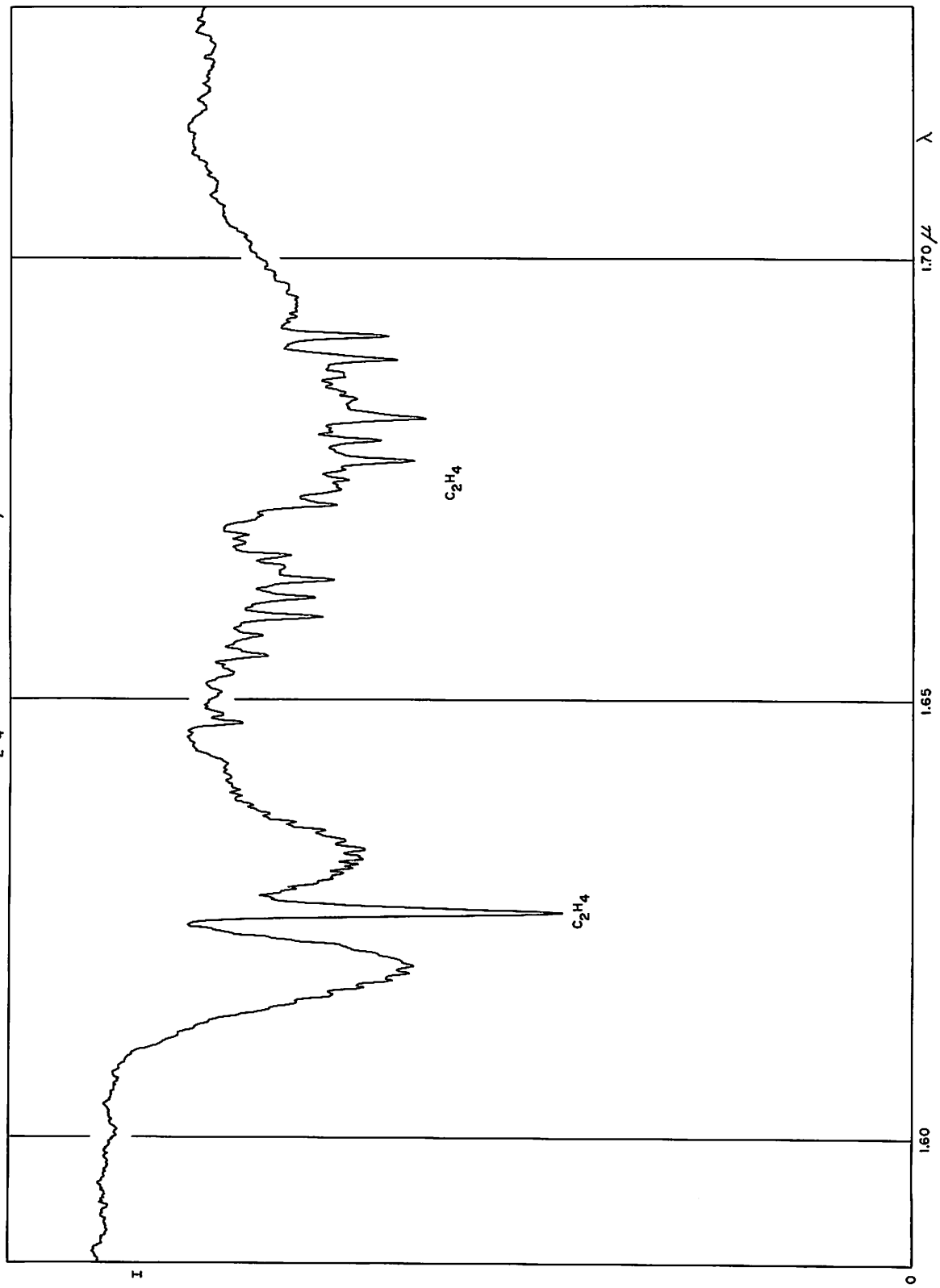

C_2H_4, (a) 11 CM AT P = 10 CM, (b) 11 CM AT 1 ATM, 1.20 — 1.85μ
I
a
b
H_2O
C_2H_4
C_2H_4
H_2O
0
0
a
b
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.55
1.60
1.65
1.70
1.75
λ
1.80μ
1.85

Fig. 5



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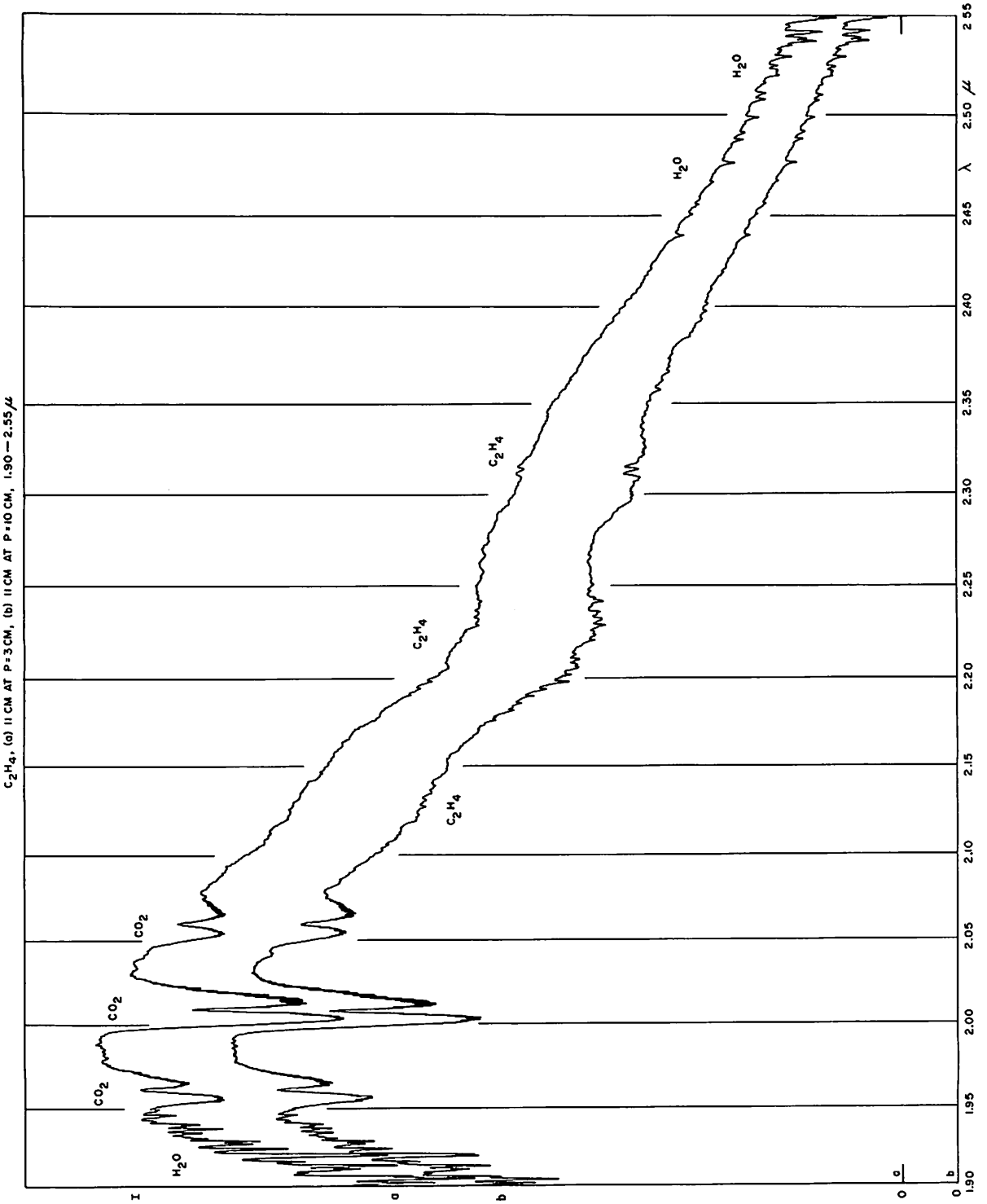
C_2H_4, (a) 11 CM AT P=3 CM, (b) 11 CM AT P=10 CM, 1.90—2.55 μ
H_2O
CO_2
CO_2
CO_2
C_2H_4
C_2H_4
C_2H_4
H_2O
H_2O
I
a
b
0
a
0
b
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
λ
2.50 μ
2.55

Fig. 7

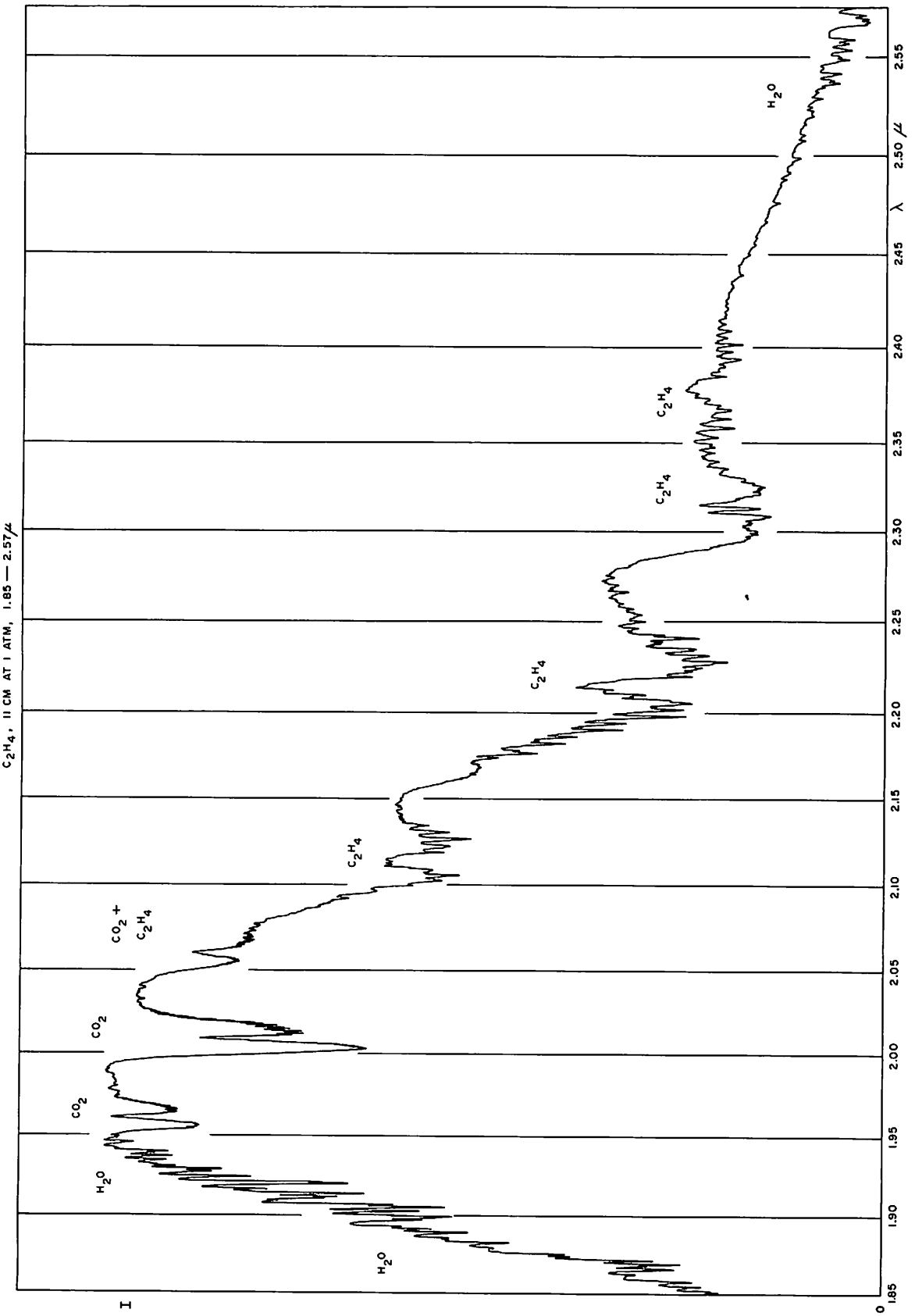
C2H4, 11 CM AT 1 ATM, 1.85 — 2.57μ
I
0
1.85
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.50 μ
λ
H2O
CO2
CO2
CO2 + C2H4
C2H4
C2H4
C2H4
C2H4
H2O
H2O

Fig. 8

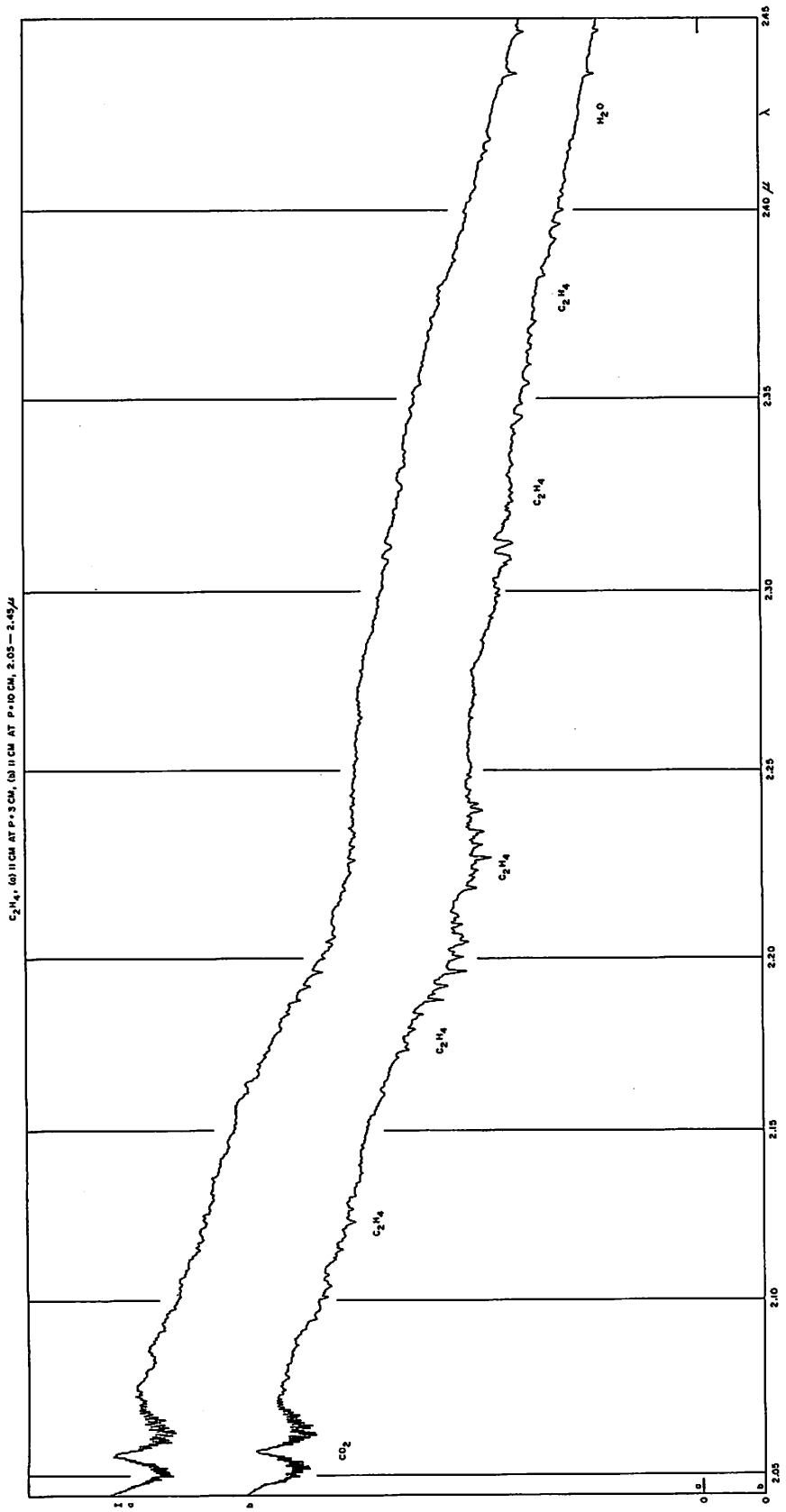
C_2H_4, (a) 11 CM AT P=3 CM, (b) 11 CM AT P=10 CM, 2.05—2.45μ
CO_2
C_2H_4
C_2H_4
C_2H_4
C_2H_4
C_2H_4
C_2H_4
H_2O
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40 μ
2.45
λ

Fig. 9

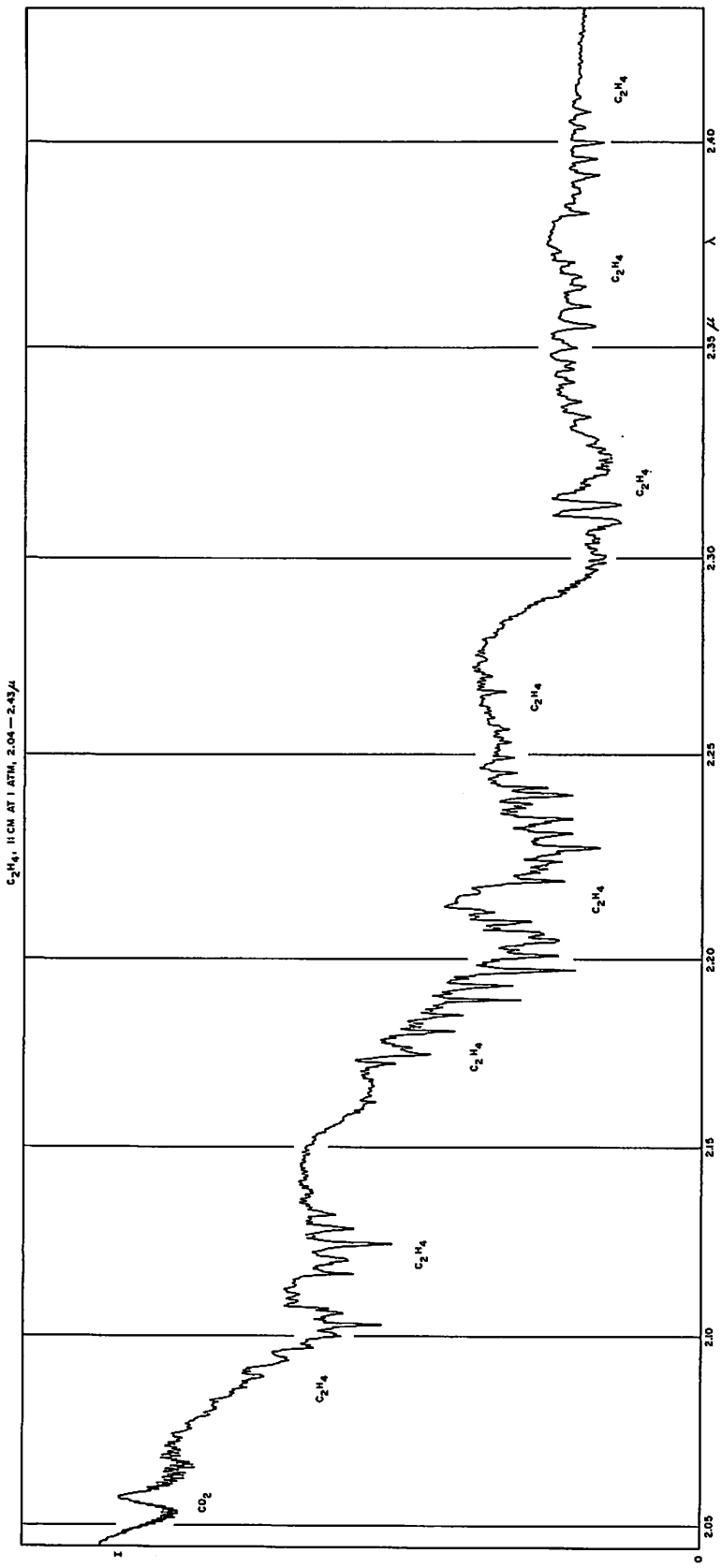
C_2H_4, 11 CM AT 1 ATM, 2.04—2.43 μ
CO_2
C_2H_4
C_2H_4
C_2H_4
C_2H_4
C_2H_4
C_2H_4
C_2H_4
C_2H_4
I
0
2.05
2.10
2.15
2.20
2.25
2.30
2.35 μ
2.40
λ

Fig. 10

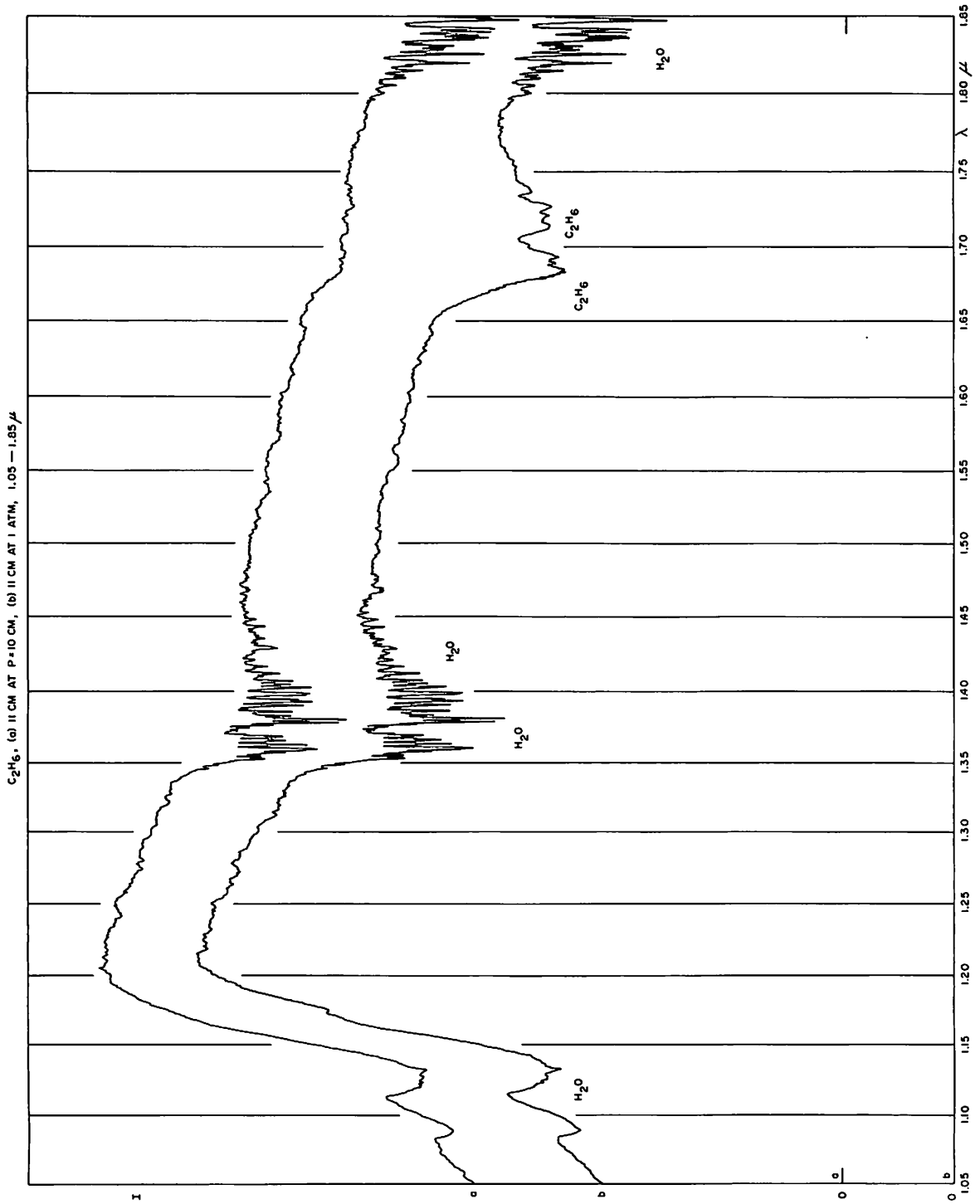
C_2H_6, (a) 11 CM AT P=10 CM, (b) 11 CM AT 1 ATM, 1.05 — 1.85 μ
H_2O
C_2H_6
C_2H_6
H_2O
H_2O
H_2O
H_2O
I
a
b
a
b
0
0
1.05
1.10
1.15
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.55
1.60
1.65
1.70
1.75
1.80 μ
λ
1.85

Fig. 11

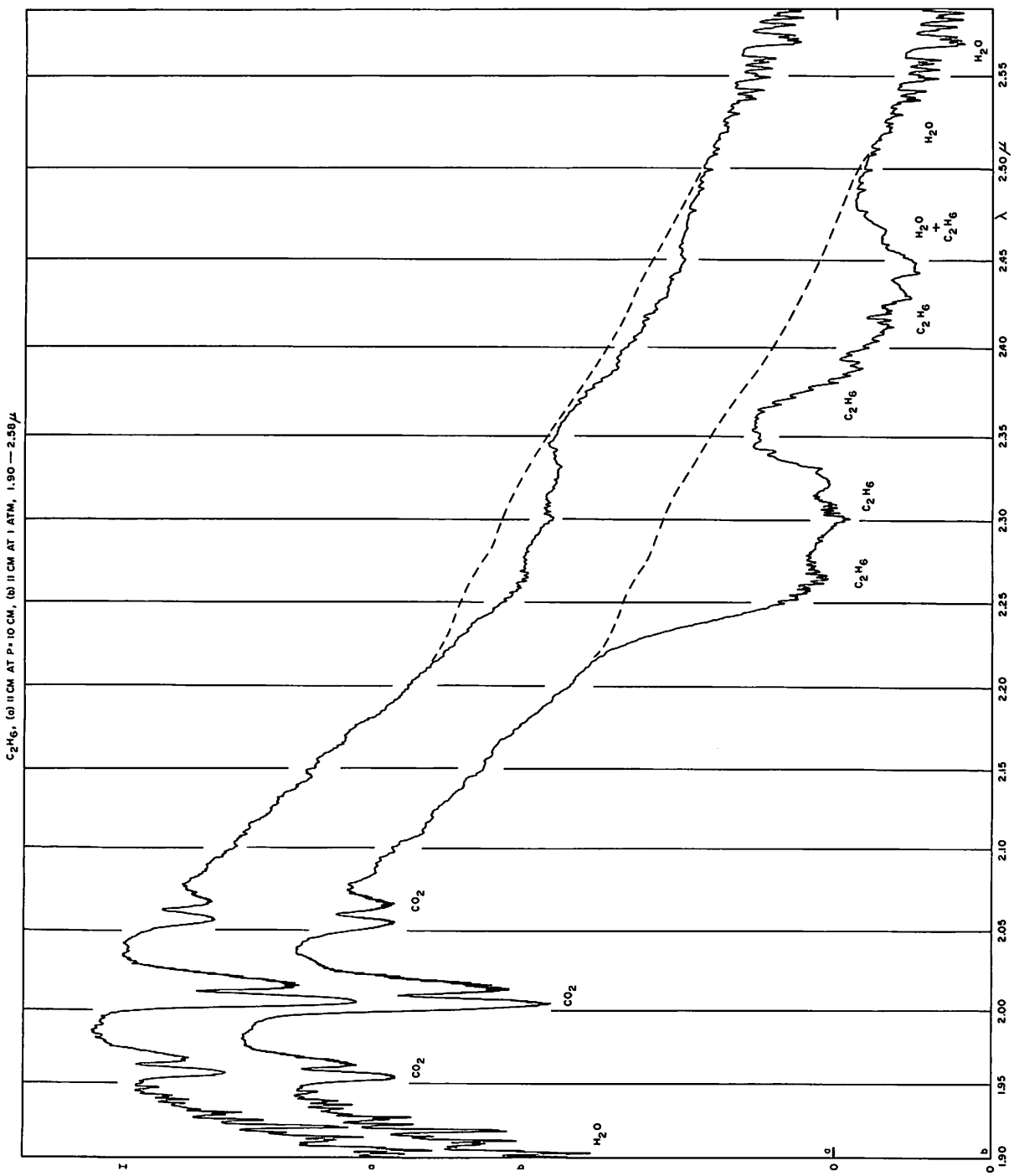
C_2H_6, (a) 11 CM AT P = 10 CM, (b) 11 CM AT 1 ATM, 1.90 — 2.59μ
CO_2
CO_2
CO_2
H_2O
C_2H_6
C_2H_6
C_2H_6
C_2H_6
H_2O
H_2O
H_2O + C_2H_6
H_2O
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.50μ
λ
2.55
a
b
I
0
0

Fig. 12

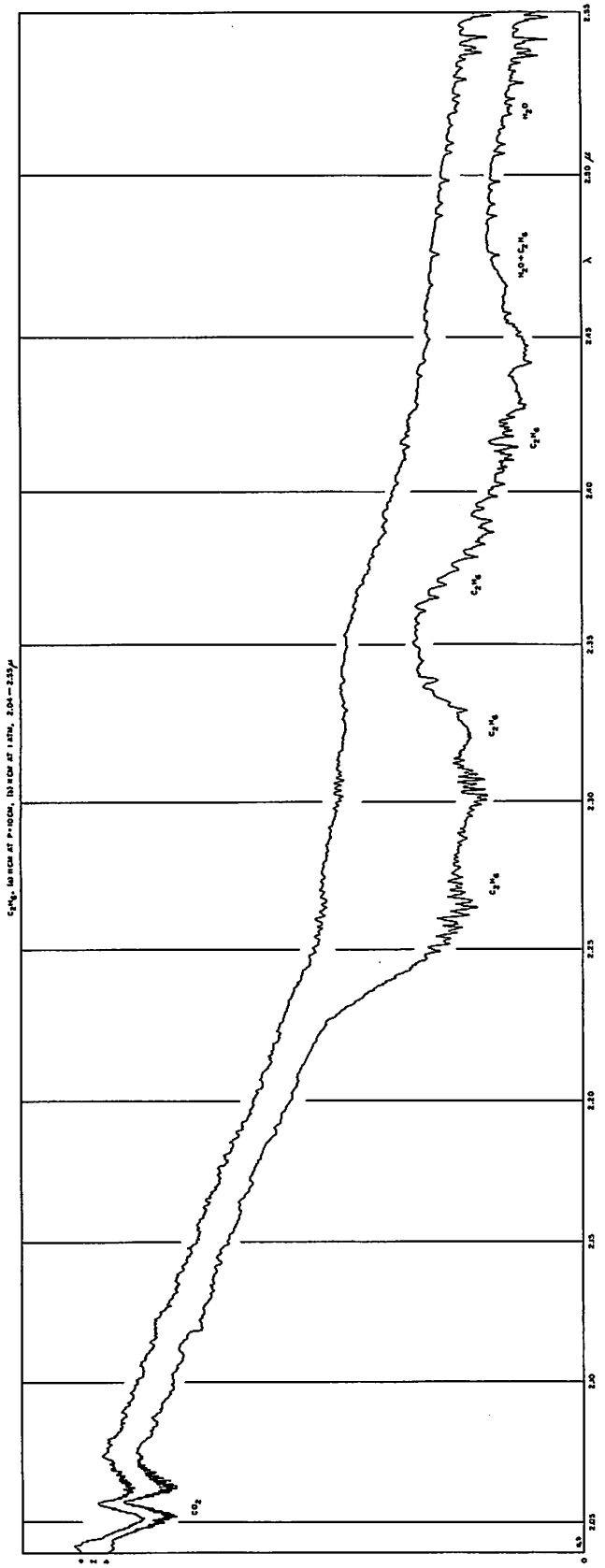

Fig. 13

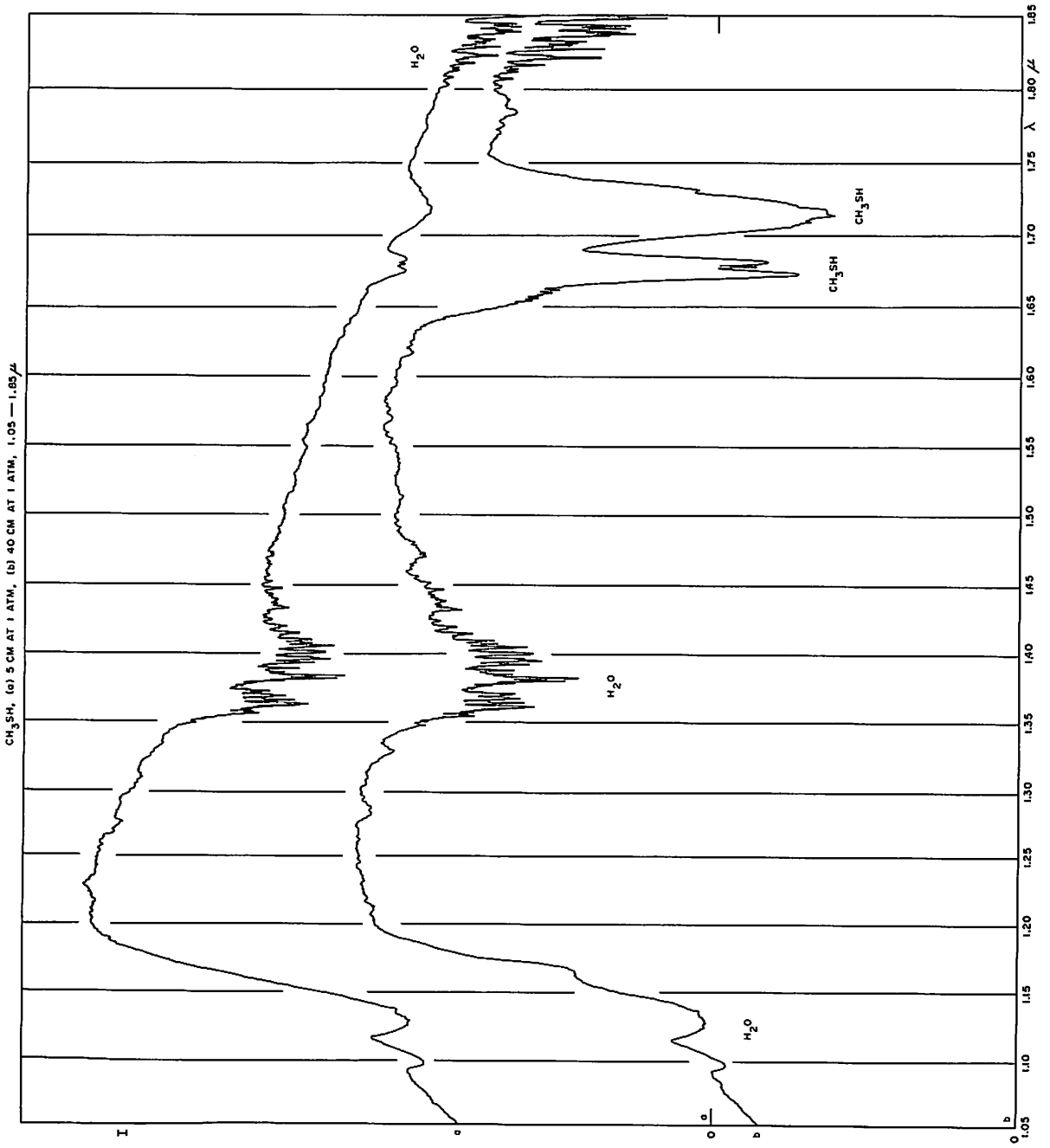
CH_3SH, (a) 5 CM AT 1 ATM, (b) 40 CM AT 1 ATM, 1.05 — 1.85 μ
H_2O
CH_3SH
CH_3SH
H_2O
H_2O
I
a
b
1.05
1.10
1.15
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.55
1.60
1.65
1.70
1.75
λ
1.80 μ
1.85

Fig. 14

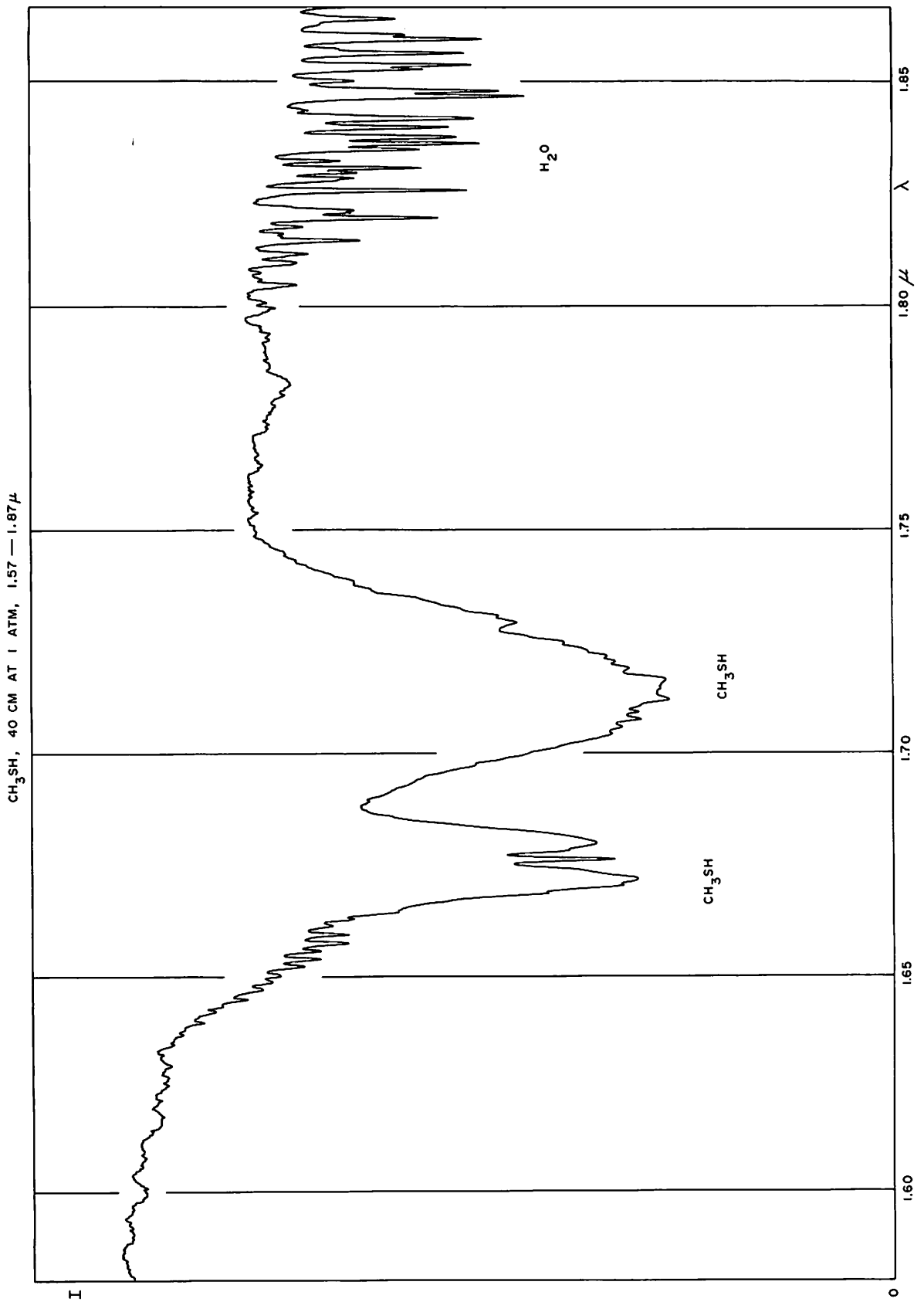
CH3SH, 40 CM AT 1 ATM, 1.57 — 1.87μ
I
0
1.60
1.65
1.70
1.75
1.80 μ
λ
1.85
H2O
CH3SH
CH3SH

Fig. 15

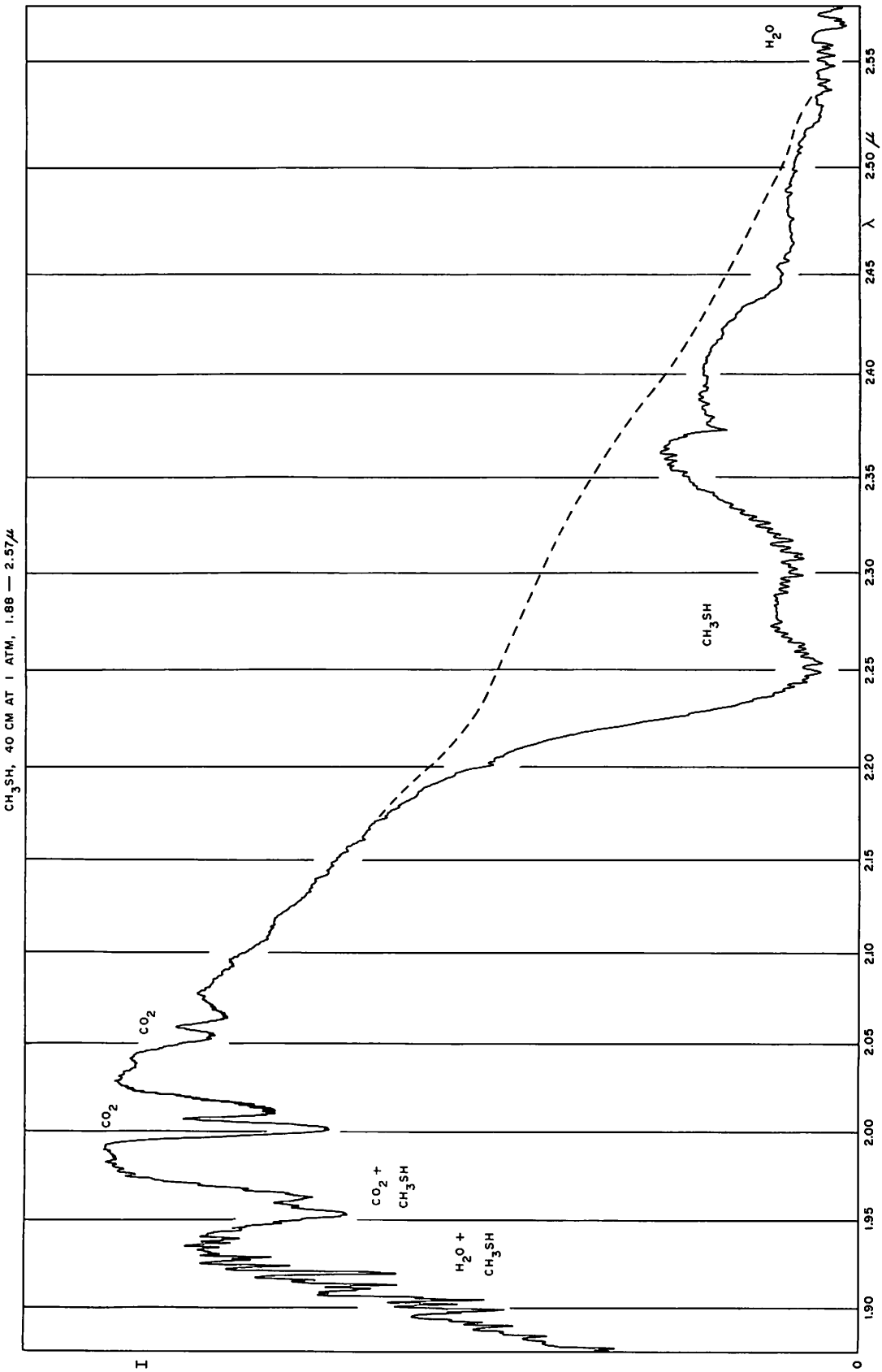
CH_3SH, 40 CM AT 1 ATM, 1.88 — 2.57μ
I
0
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.50 μ
λ
2.55
CO_2
CO_2
CO_2 + CH_3SH
H_2O + CH_3SH
CH_3SH
H_2O

Fig. 16

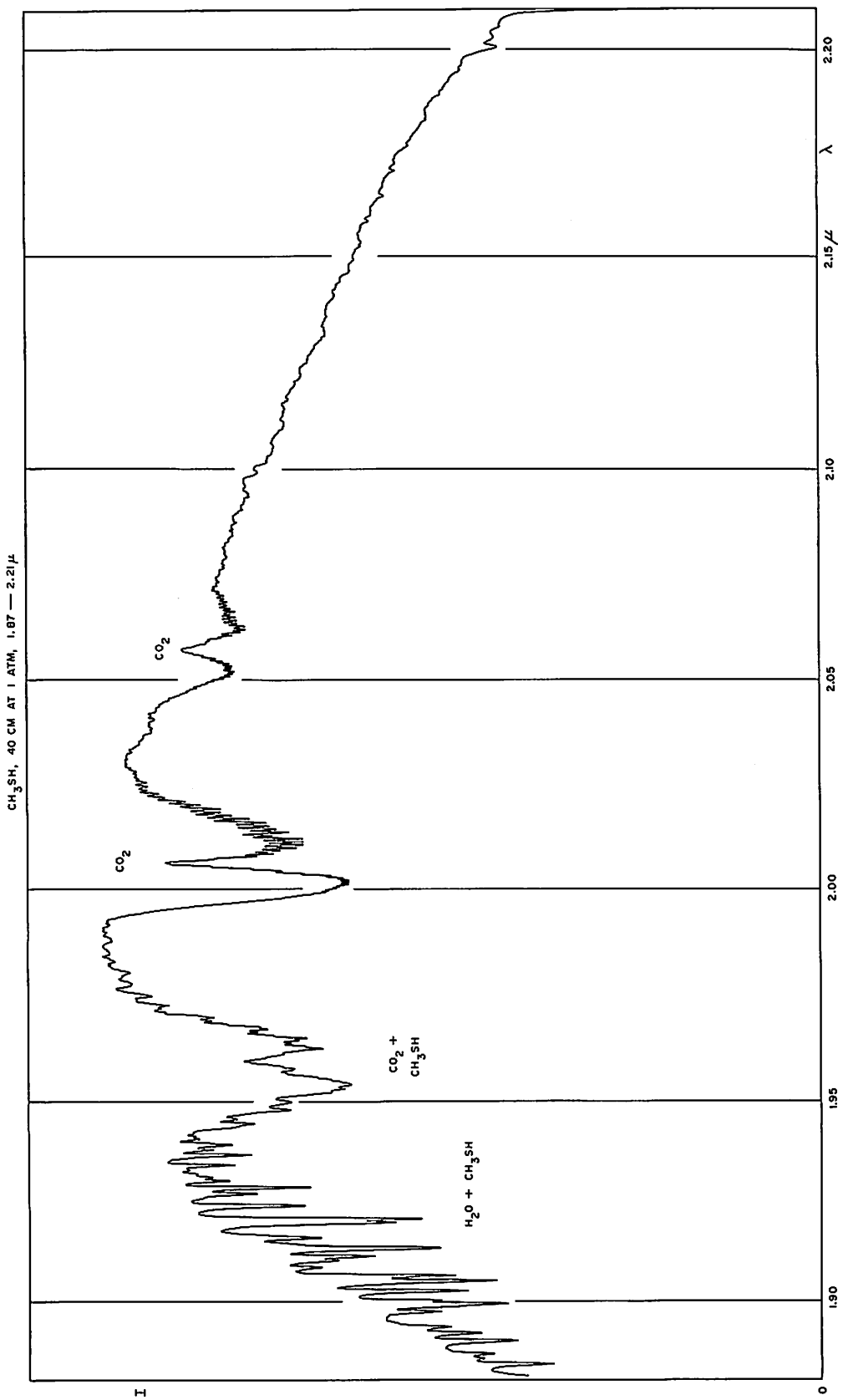
CH_3SH, 40 CM AT 1 ATM, 1.87 — 2.21 μ
I
0
1.90
1.95
2.00
2.05
2.10
2.15 μ
2.20
λ
CO_2
CO_2
CO_2 + CH_3SH
H_2O + CH_3SH

Fig. 17

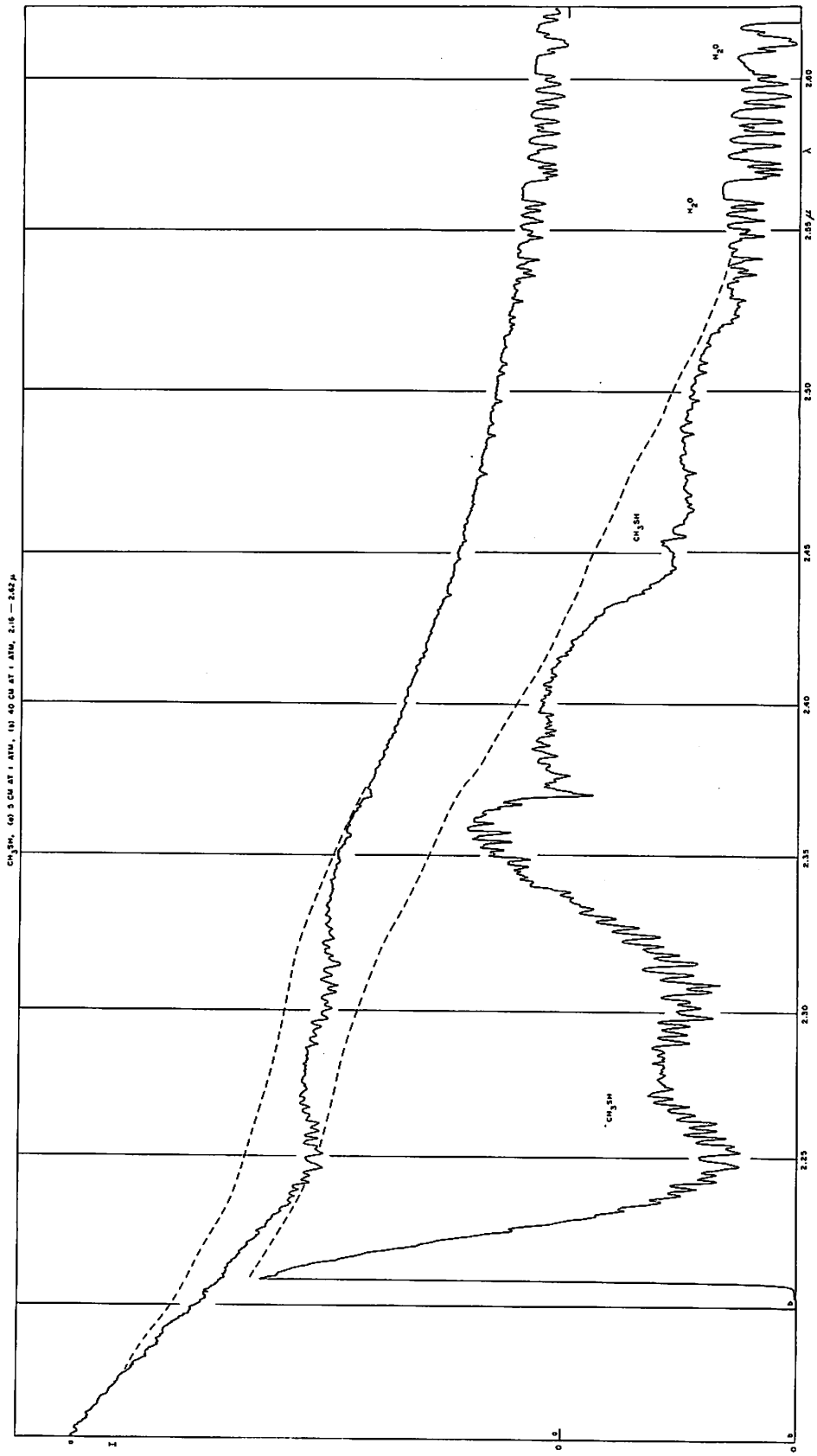
CH_3SH, (a) 5 CM AT 1 ATM, (b) 40 CM AT 1 ATM, 2.16 — 2.62 μ
H_2O
H_2O
CH_3SH
CH_3SH
I
λ
2.60
2.55 μ
2.50
2.45
2.40
2.35
2.30
2.25
0
0
0

Fig. 18

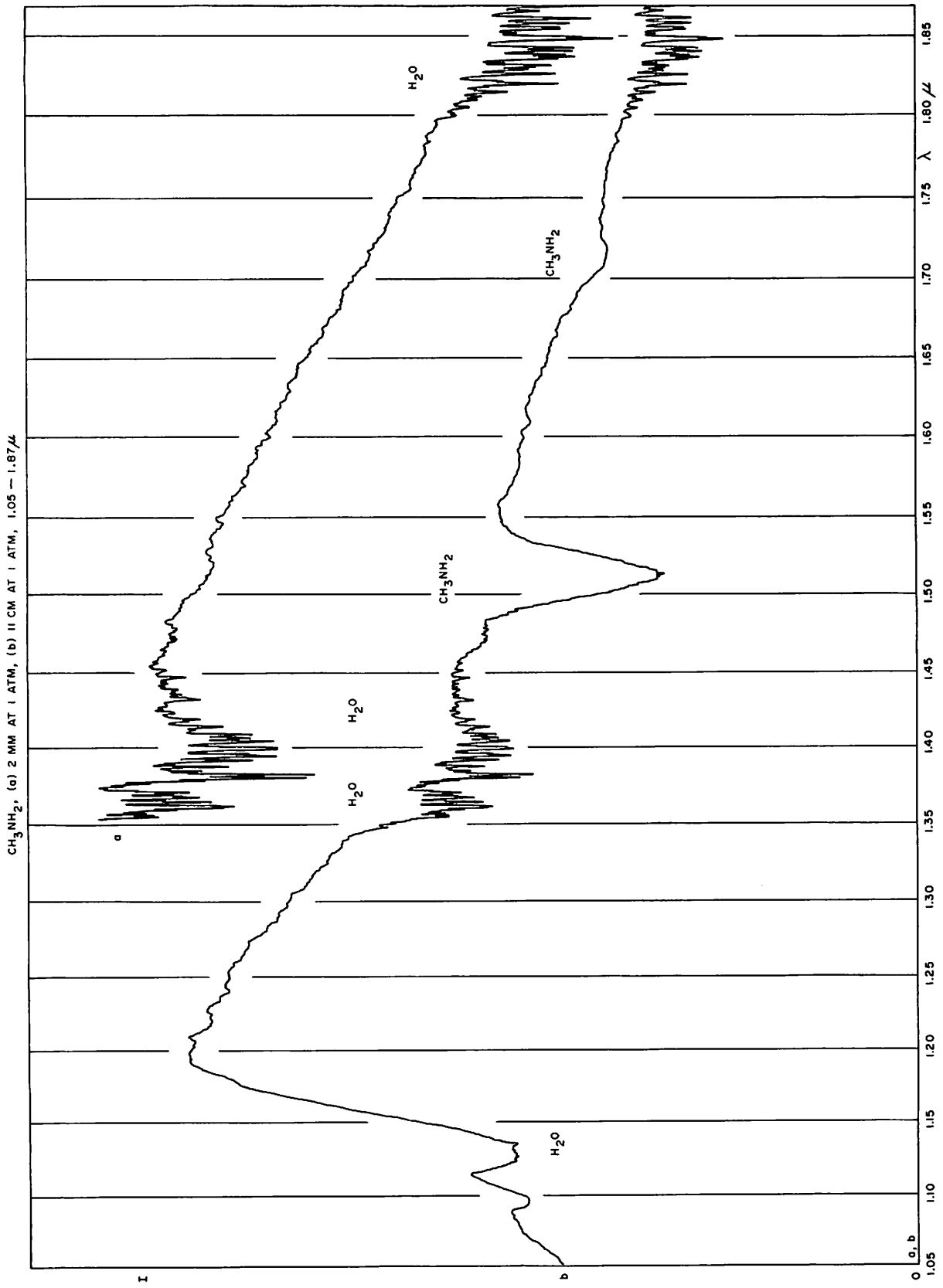
CH_3NH_2, (a) 2 MM AT 1 ATM, (b) 11 CM AT 1 ATM, 1.05 – 1.87μ
H_2O
CH_3NH_2
H_2O
CH_3NH_2
H_2O
H_2O
a
b
I
0
a, b
1.05
1.10
1.15
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.55
1.60
1.65
1.70
1.75
1.80 μ
λ
1.85

Fig. 19

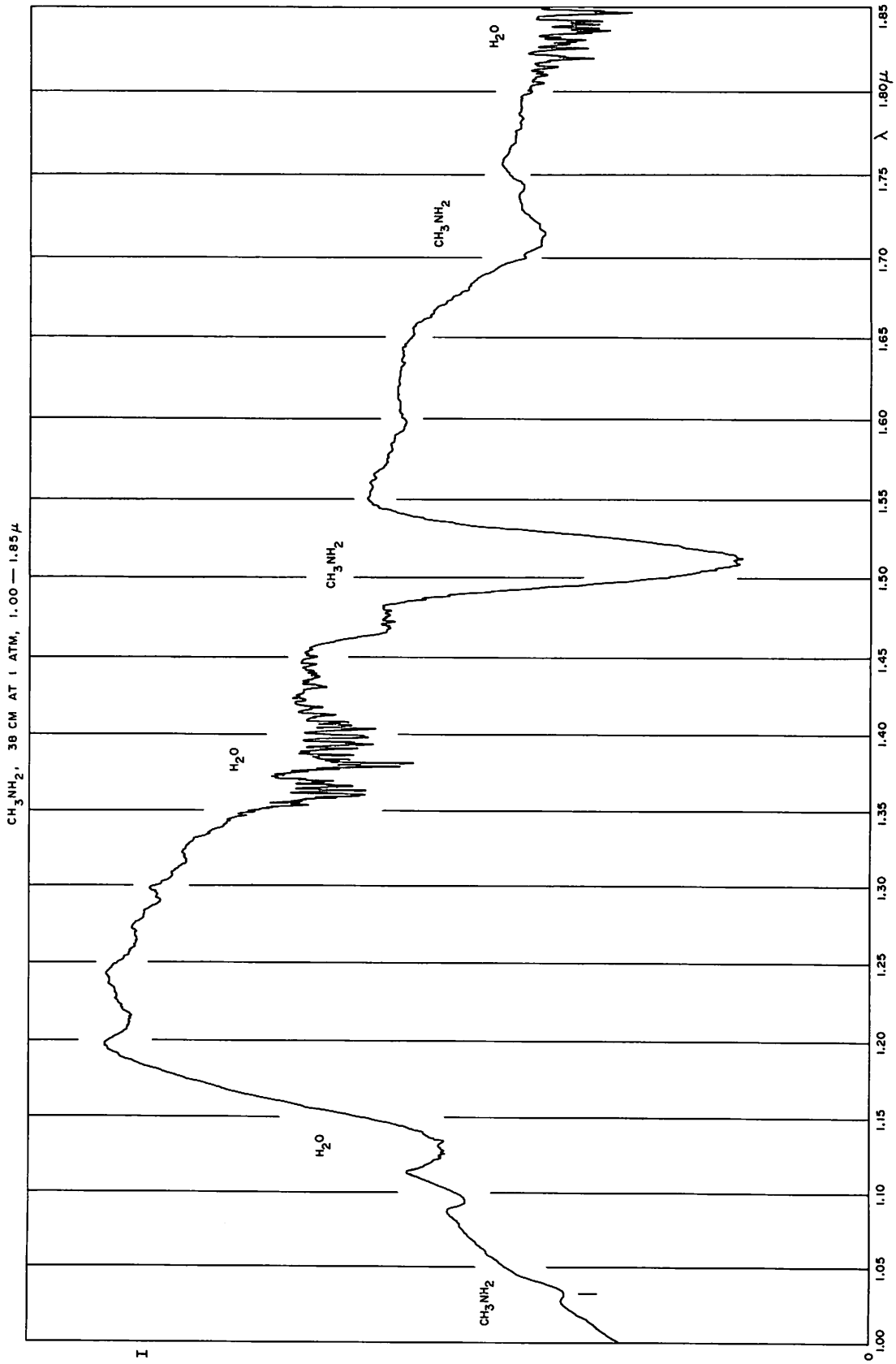
CH_3NH_2, 38 CM AT 1 ATM, 1.00 — 1.85μ
I
0
1.00
1.05
1.10
1.15
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.55
1.60
1.65
1.70
1.75
λ
1.80μ
1.85
H_2O
CH_3NH_2
H_2O
CH_3NH_2
H_2O
CH_3NH_2

Fig. 20

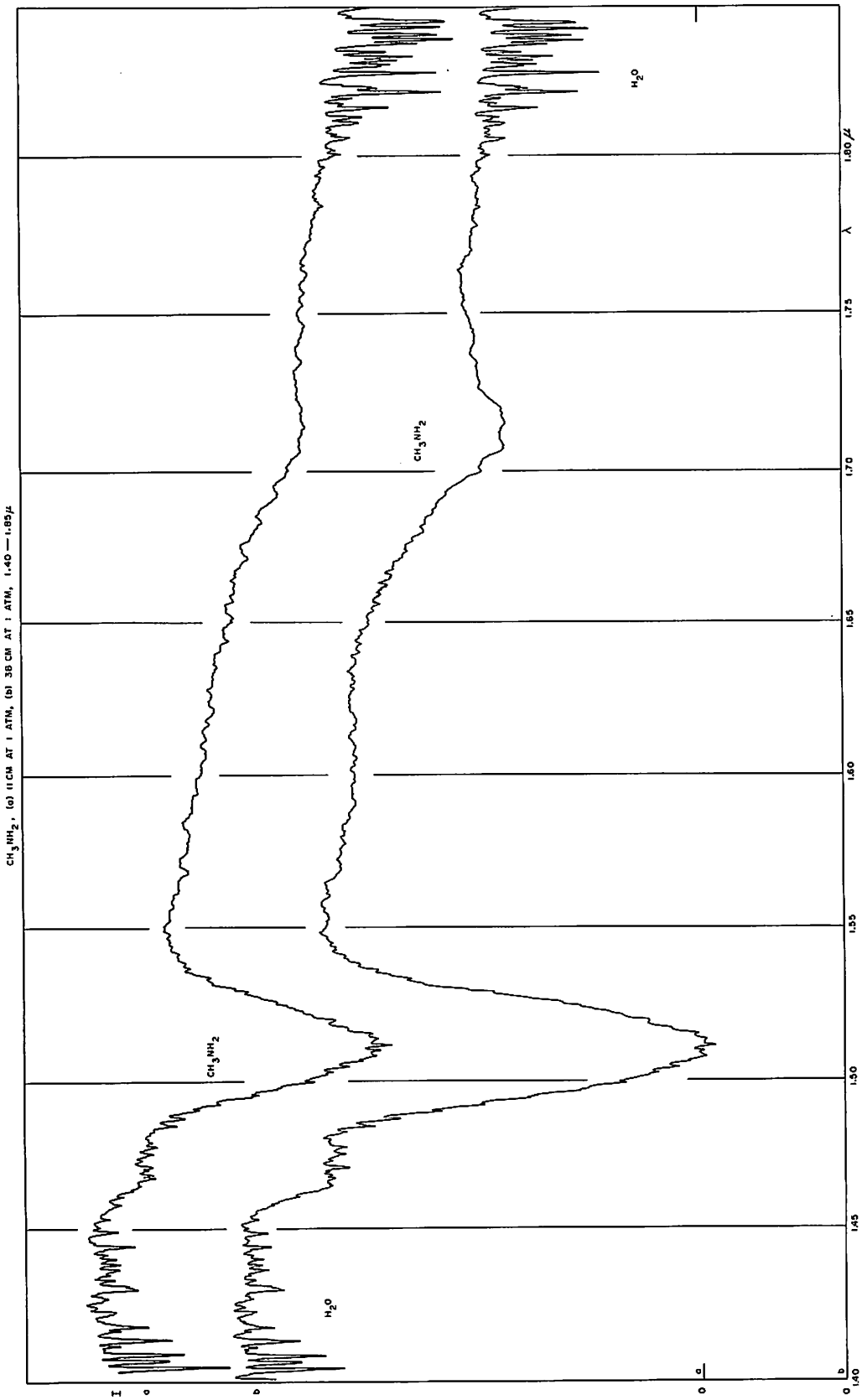
CH_3NH_2, (a) 11 CM AT 1 ATM, (b) 38 CM AT 1 ATM, 1.40 — 1.85μ
CH_3NH_2
H_2O
CH_3NH_2
H_2O
I
a
b
0
0
1.40
1.45
1.50
1.55
1.60
1.65
1.70
1.75
1.80 μ
λ

Fig. 21

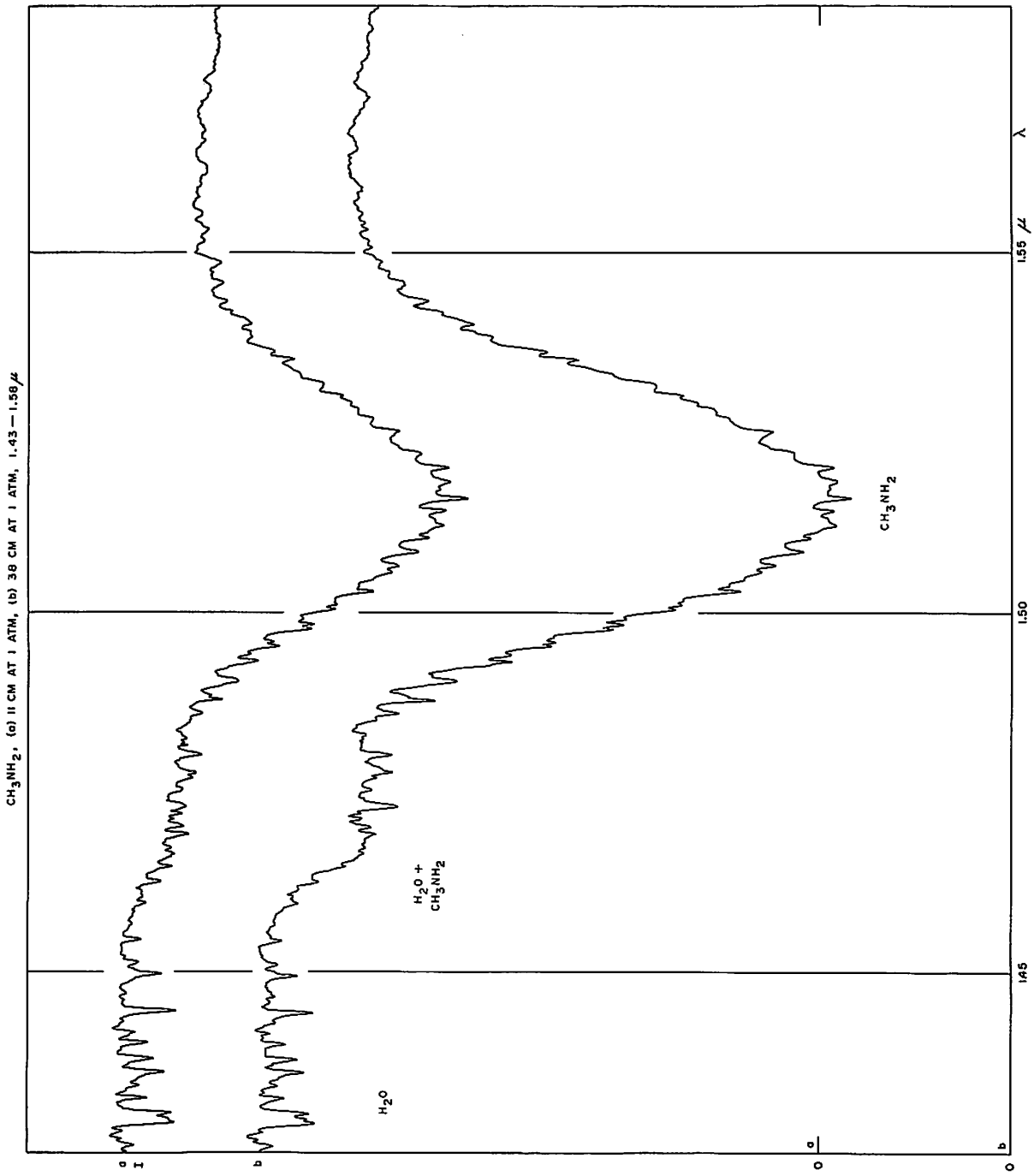
CH_3NH_2, (a) 11 CM AT 1 ATM, (b) 38 CM AT 1 ATM, 1.43 — 1.58 μ
a
I
b
H_2O
$H_2O + CH_3NH_2$
CH_3NH_2
a
0
b
0
1.45
1.50
1.55 μ
λ

Fig. 22

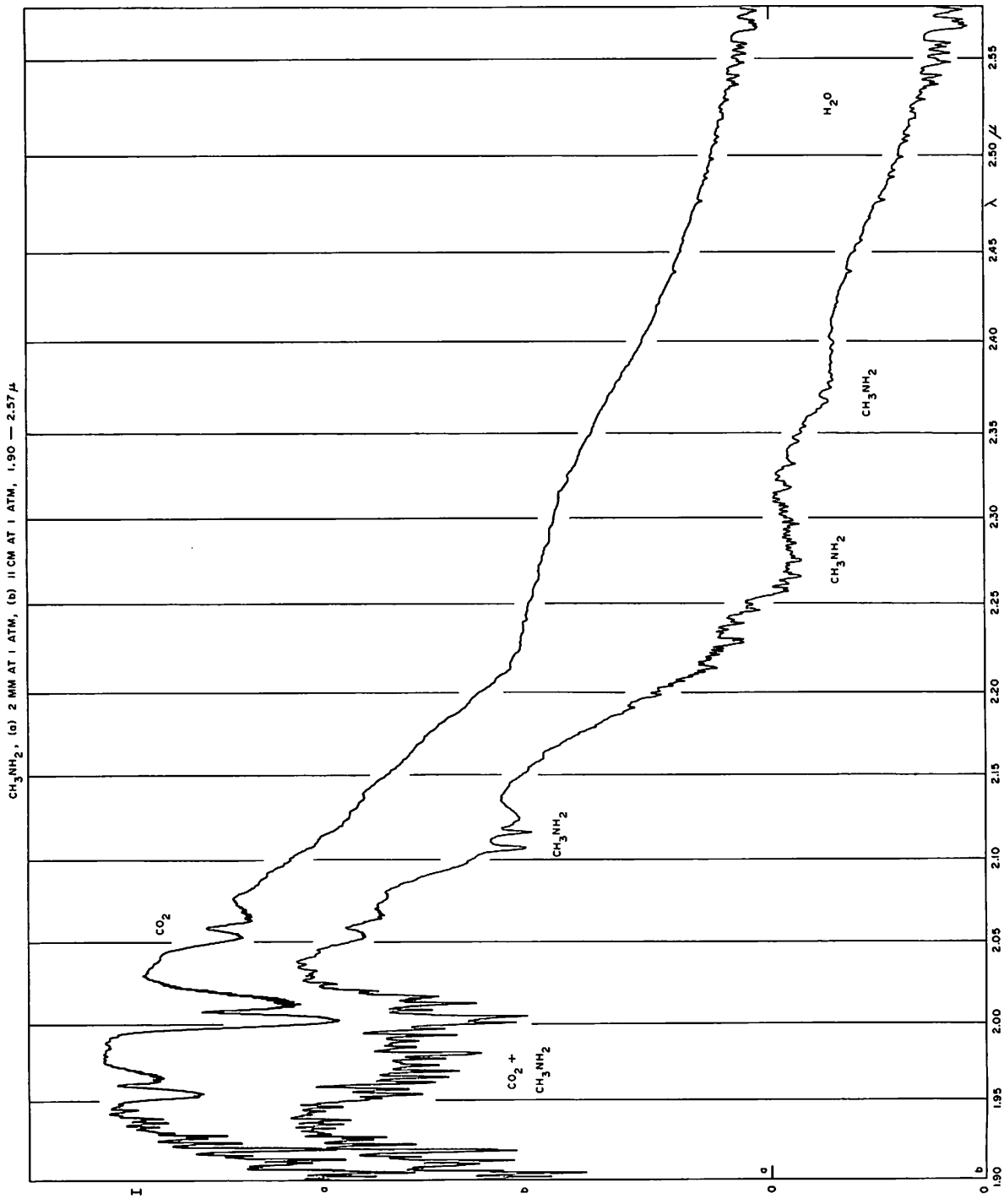
CH_3NH_2, (a) 2 MM AT 1 ATM, (b) 11 CM AT 1 ATM, 1.90 — 2.57 μ
CO_2
CO_2 + CH_3NH_2
CH_3NH_2
CH_3NH_2
CH_3NH_2
H_2O
I
λ
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.50 μ
2.55

Fig. 23

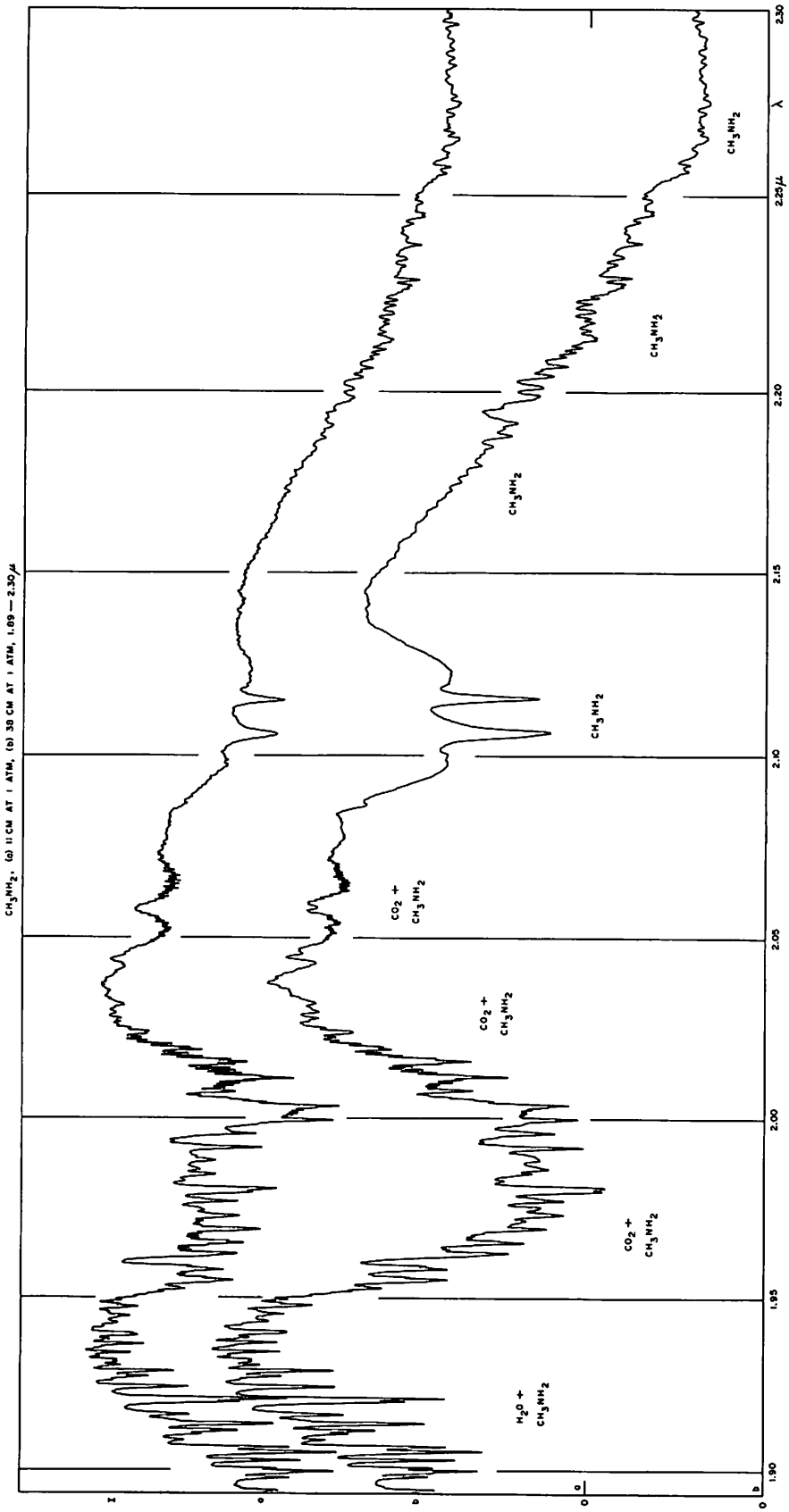
CH_3NH_2, (a) 11 CM AT 1 ATM, (b) 38 CM AT 1 ATM, 1.89 — 2.30μ
I
a
b
a
b
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25μ
2.30
λ
H_2O + CH_3NH_2
CO_2 + CH_3NH_2
CO_2 + CH_3NH_2
CO_2 + CH_3NH_2
CH_3NH_2
CH_3NH_2
CH_3NH_2
CH_3NH_2

Fig. 24

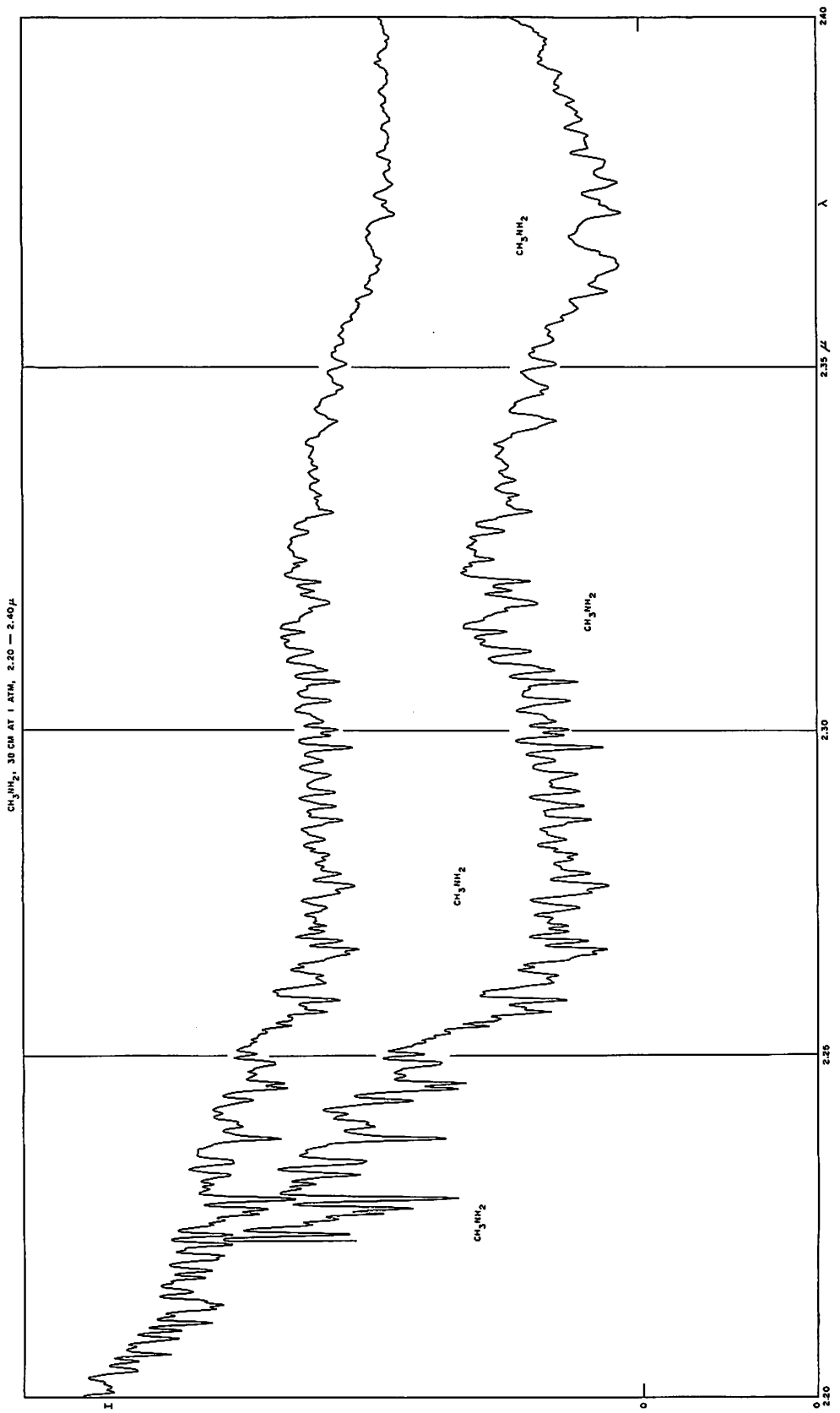
CH_3NH_2, 30 CM AT 1 ATM, 2.20 — 2.40μ
I
0
2.20
2.25
2.30
2.35 μ
2.40
λ
CH_3NH_2
CH_3NH_2
CH_3NH_2
CH_3NH_2

Fig. 25

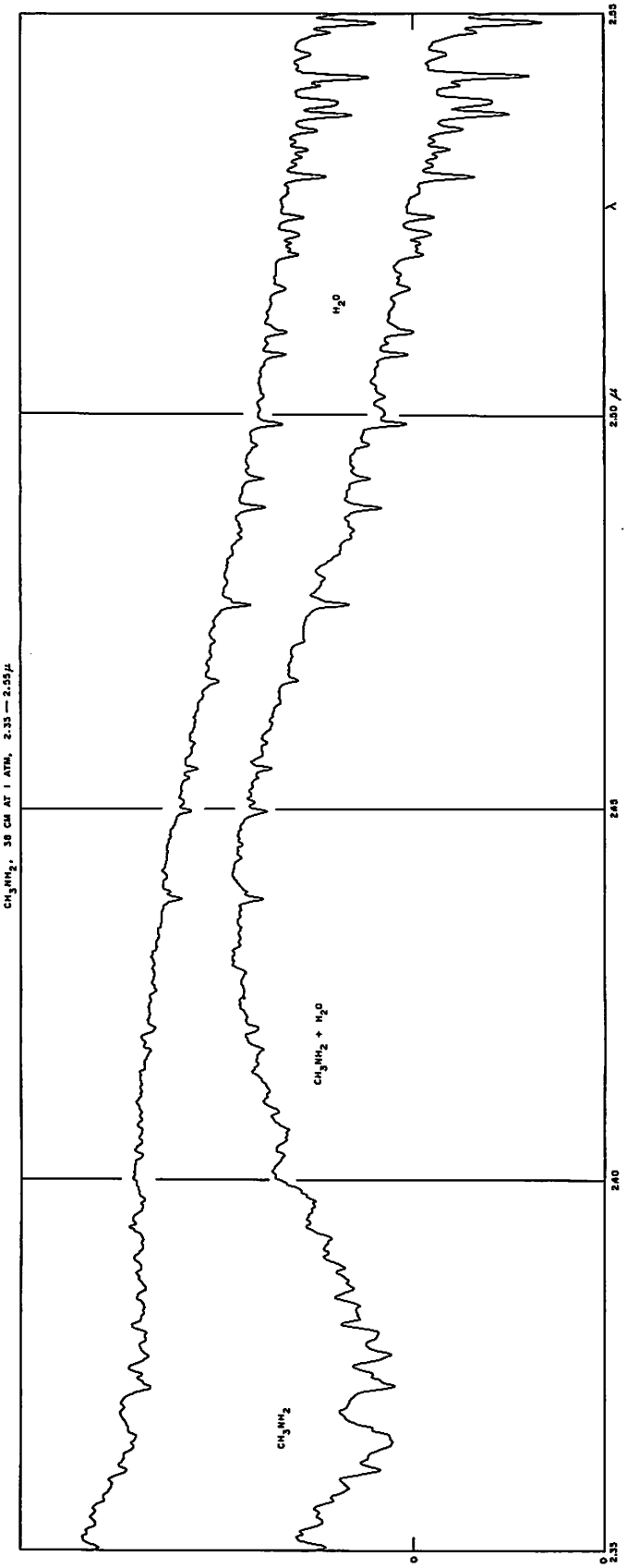
CH_3NH_2, 38 CM AT 1 ATM, 2.35 — 2.55μ
CH_3NH_2
$CH_3NH_2 + H_2O$
H_2O
2.35
2.40
2.45
2.50 μ
λ
0
0
2.35

Fig. 26

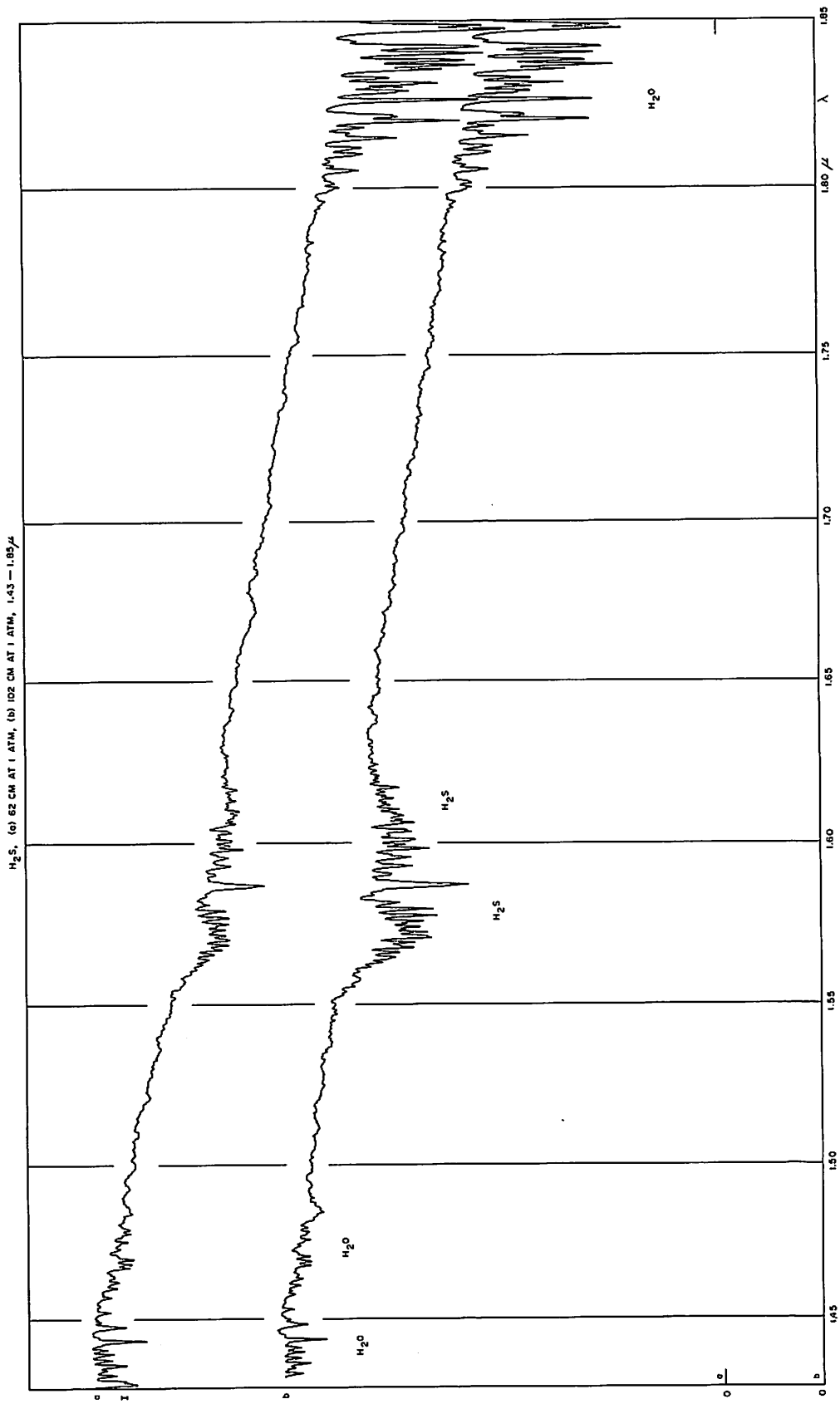
H_2S, (a) 62 CM AT 1 ATM, (b) 102 CM AT 1 ATM, 1.43 — 1.85μ
H_2O
H_2S
H_2S
H_2O
H_2O
1.85
λ
1.80 μ
1.75
1.70
1.65
1.60
1.55
1.50
1.45
a
b
I
0
0
0

Fig. 27

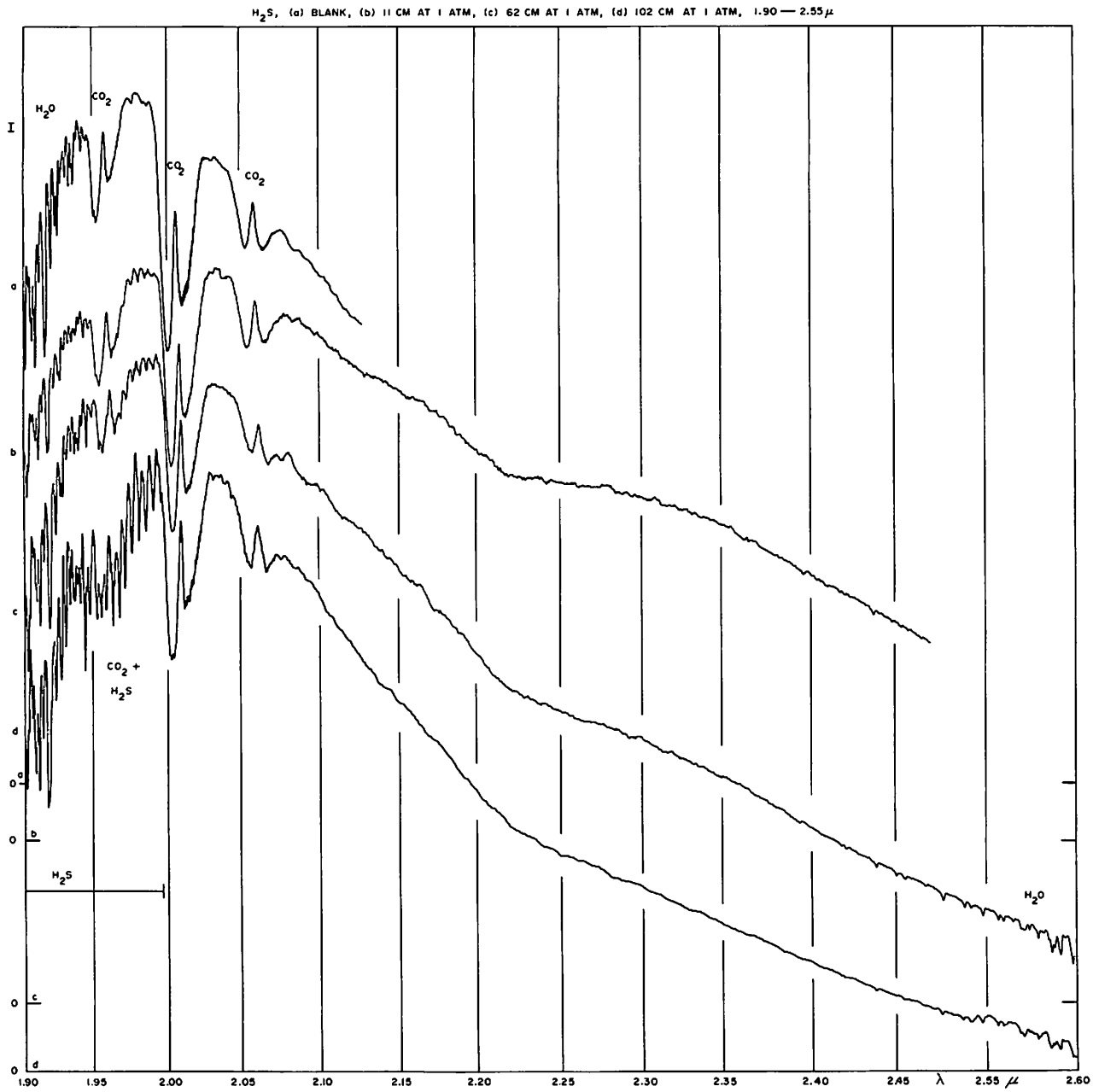
H_2S, (a) BLANK, (b) 11 CM AT 1 ATM, (c) 62 CM AT 1 ATM, (d) 102 CM AT 1 ATM, 1.90 — 2.55 μ
H_2O
CO_2
CO_2
CO_2
CO_2 + H_2S
H_2S
H_2O
I
a
b
c
d
0
0
0
0
1.90
1.95
2.00
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
λ
2.55 μ
2.60

Fig. 28

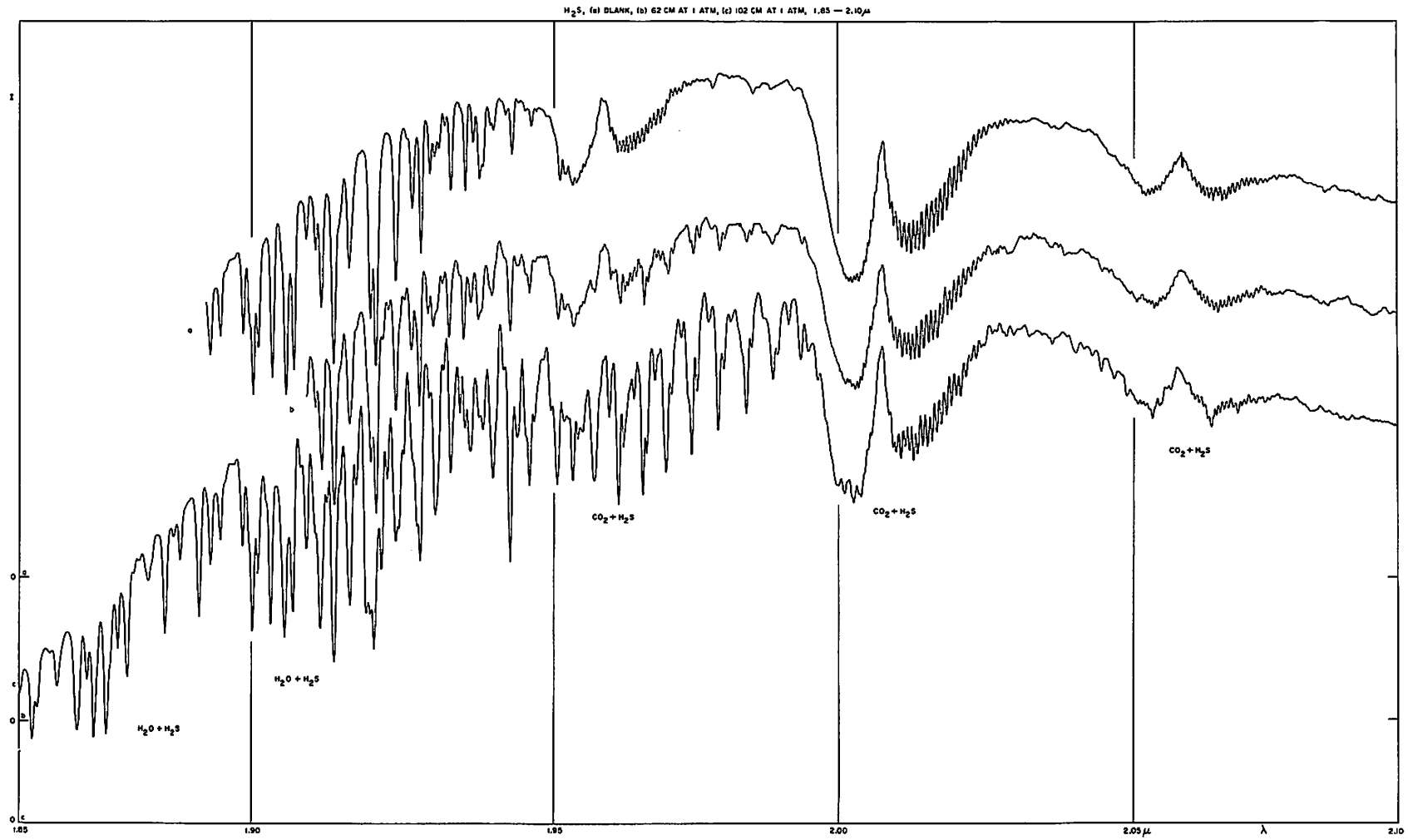
H_2S, (a) BLANK, (b) 62 CM AT 1 ATM, (c) 102 CM AT 1 ATM, 1.85 — 2.10μ
I
a
b
c
$H_2O + H_2S$
$H_2O + H_2S$
$CO_2 + H_2S$
$CO_2 + H_2S$
$CO_2 + H_2S$
1.85
1.90
1.95
2.00
2.05 μ
λ
2.10

Fig. 29