

Mesospheric Temperature Observation Using a Michelson Interferometer

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Overview

- **Project Details**
- **Background Information**
- **Data Collection Method**
- **Data Analysis Software**
- **Results**
- **Future Study**

Project Overview

- **Michelson interferometer set up**
- **Software written**
- **Data collected**
- **Aboard ship from CA to Antarctica in November**
- **Design work**

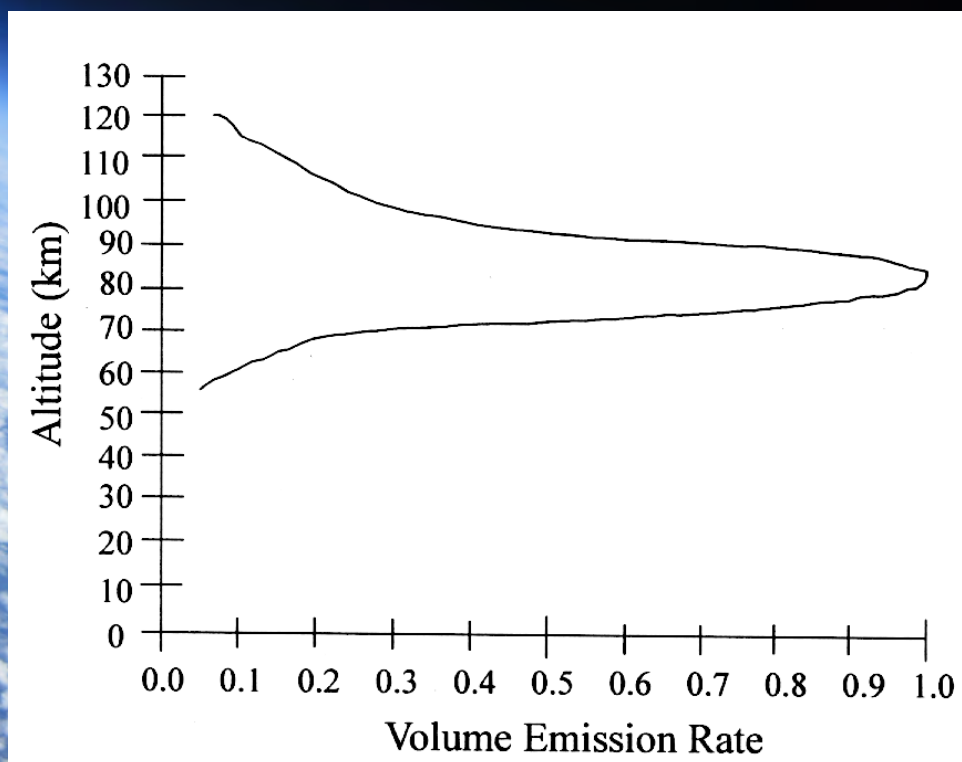
The Mesosphere/Lower Thermosphere (MLT)

- 80-105 km above Earth
- Very dynamic
- Tides
- Airglow Spectral Analysis

Hydroxyl (OH)

Image Credit: D. J. Baker and A. T. Stair, Jr., *Physica Scripta*, 37,611 (1988).

- Thermal equilibrium
- Displacement Reaction
 $\text{H} + \text{O}_3 \rightarrow \text{OH}^* + \text{O}_2 + 3.3 \text{ eV}$
- Meinel Bands
- Temperature Correlation



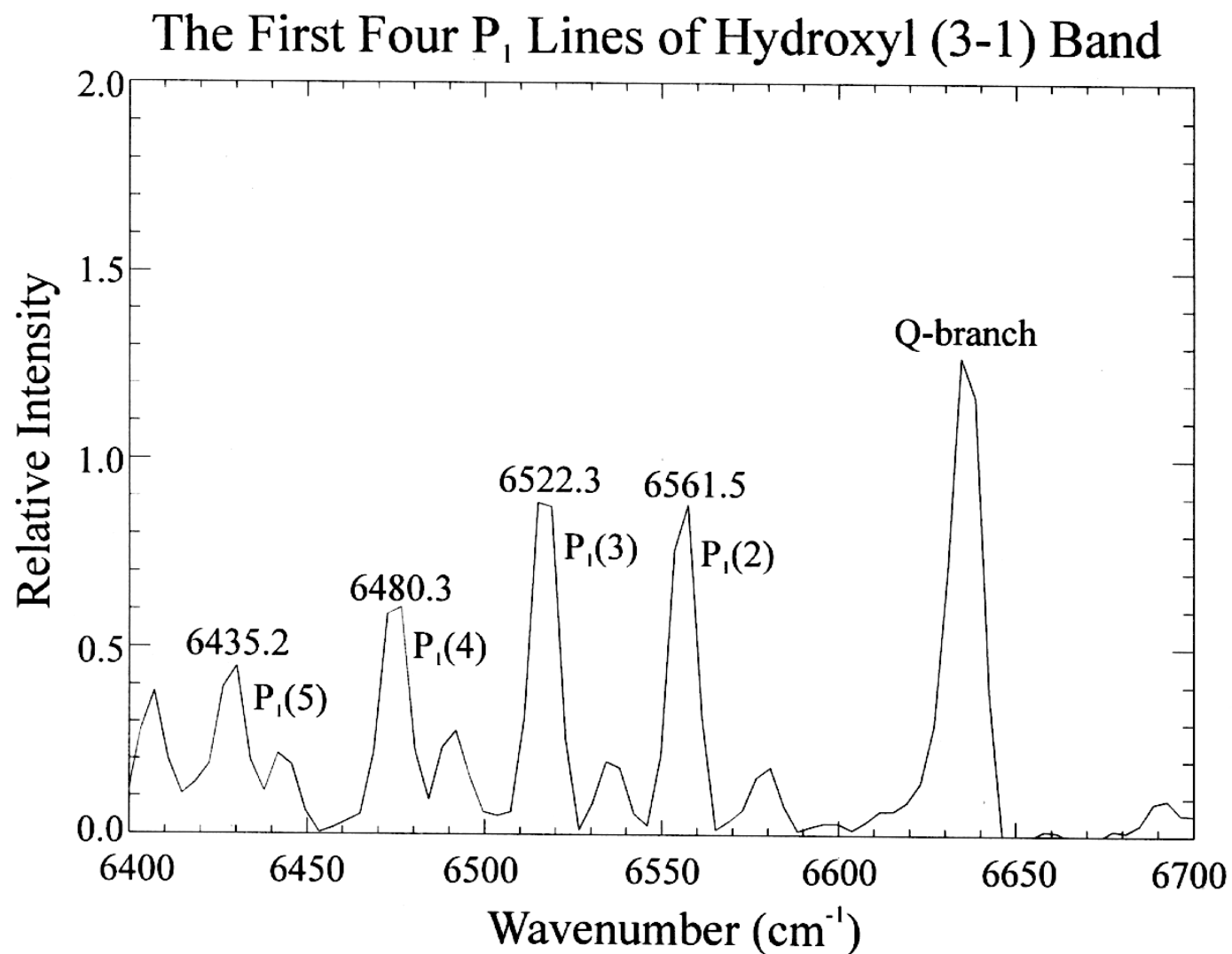
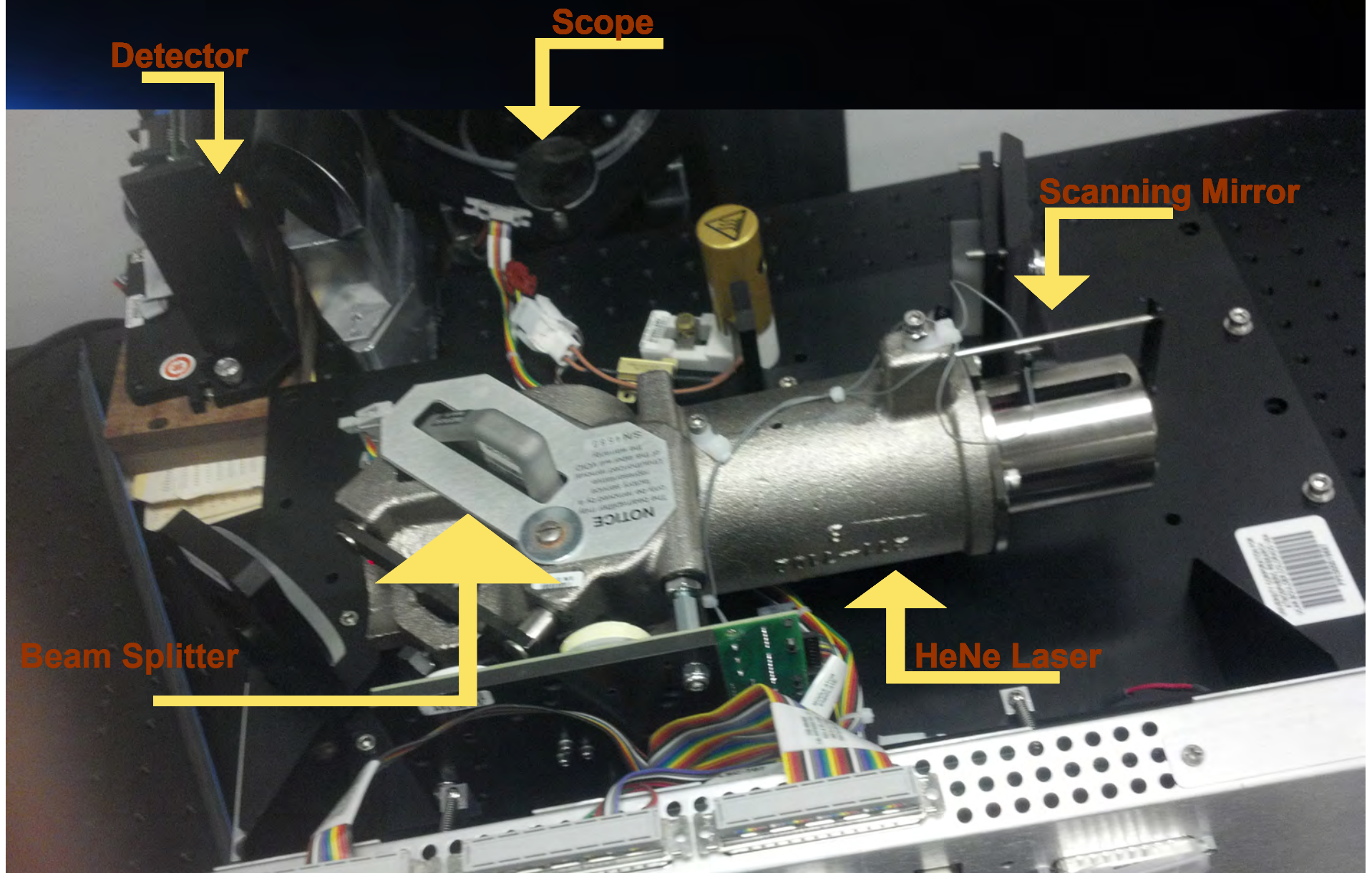


Image Credit: Application of a Michelson Interferometer to Measurements of OH Rotational Temperatures, Won *et al*, Journal of the Korean Physical Society, Vol. 34, No. 4, April 1999, pp.344~349

Data Collection

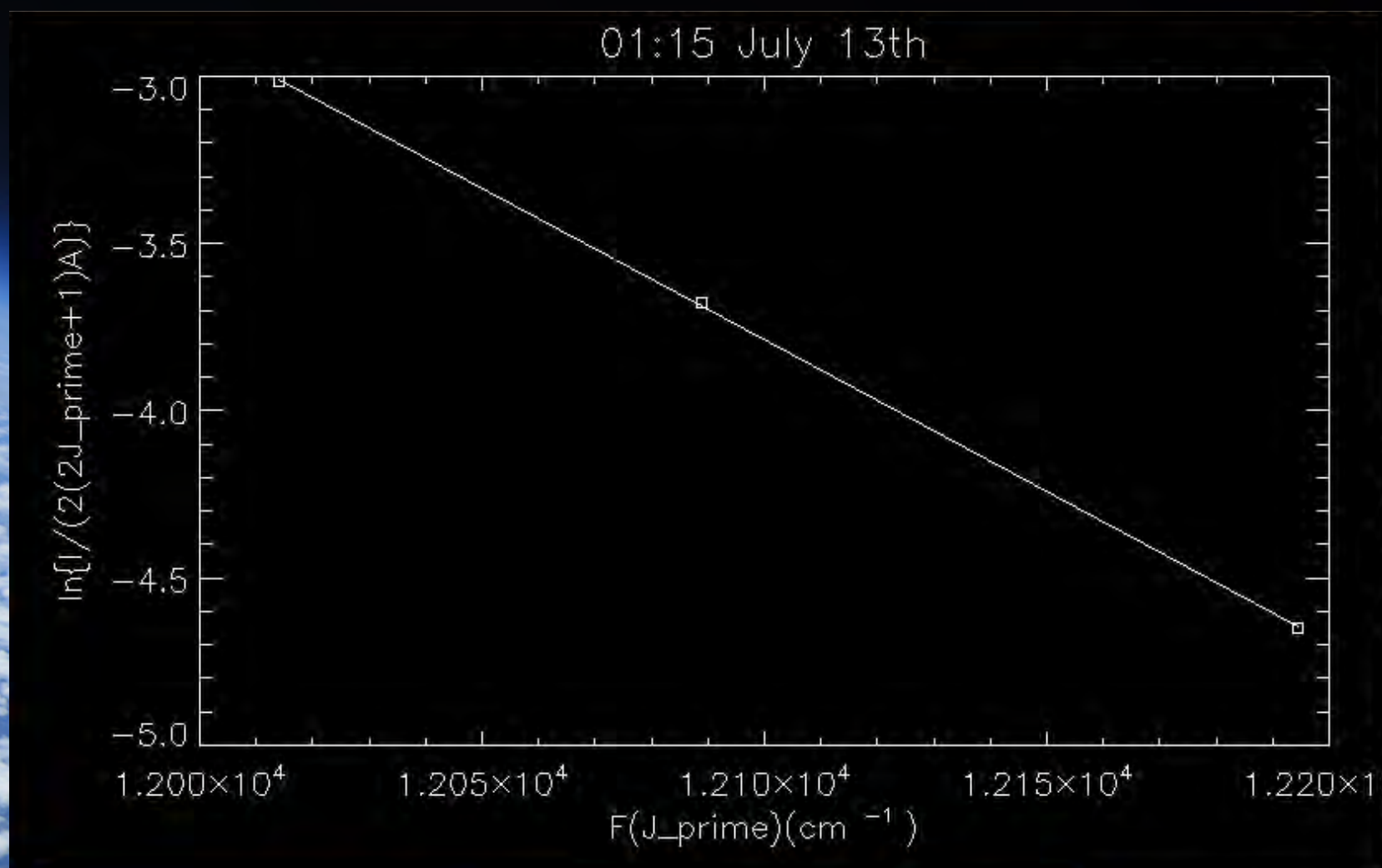
- Nicolette 6700 Spectrometer
- InGaAs Detector
- Scope
- Macro
- Terdiurnal Tide

The Interferometer



Temperature Determination

- Relationship of photon emission intensity to upper state angular momentum for Boltzmann distribution of multiplet rotational levels
- Relative intensity at expected peaks (I)
- $\ln(I/(2 \cdot A(2 \cdot J' + 1)))$
 - J' : Total Upper Angular Momentum (1.5, 2.5, 3.5)
 - $A(J')$: Einstein Constants (16.74, 20.37, 21.82 s⁻¹)
- Plotted vs. $F(J')$
 - $F(J')$: Rotational Term Values (12,014.1, 12,089.0, 12194.5 cm⁻¹)
 - Linear least squares fitted
- $T = -100 \cdot h \cdot c / (k \cdot \text{slope})$
 - H : Planck's Constant
 - C : Speed of Light
 - K : Boltzmann's Constant

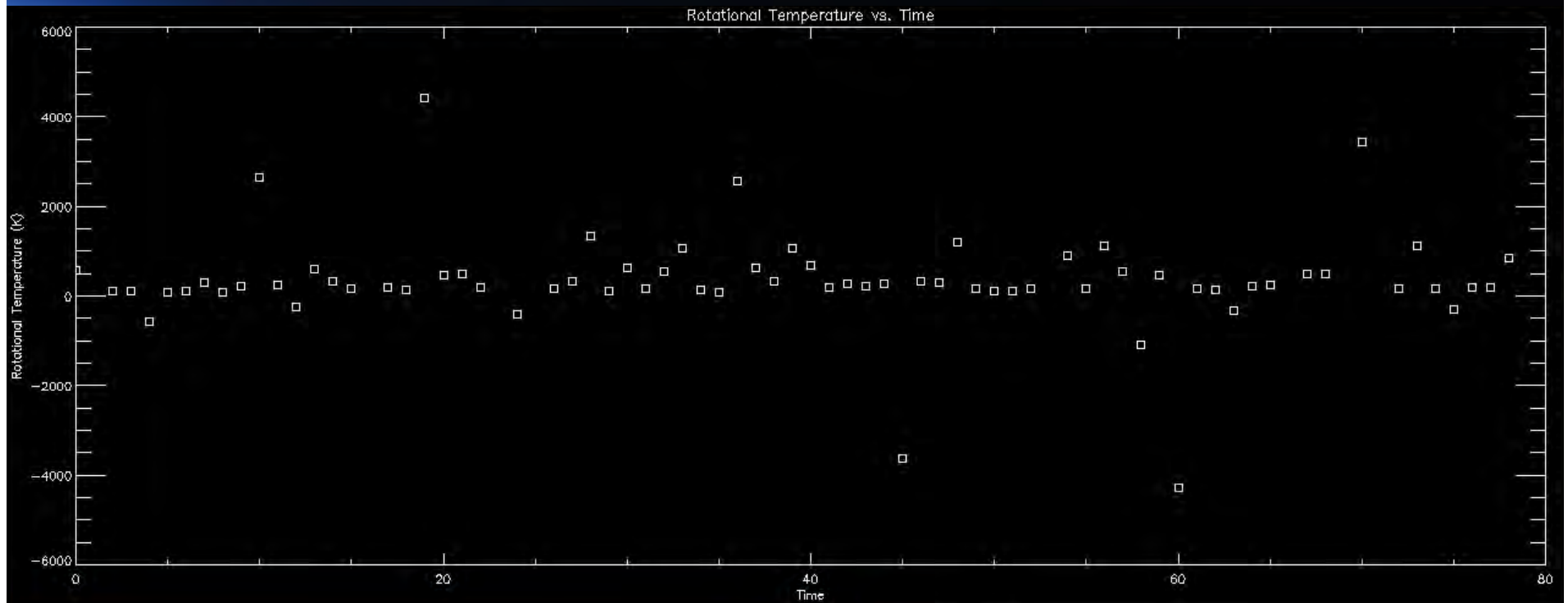


T=158.7 K

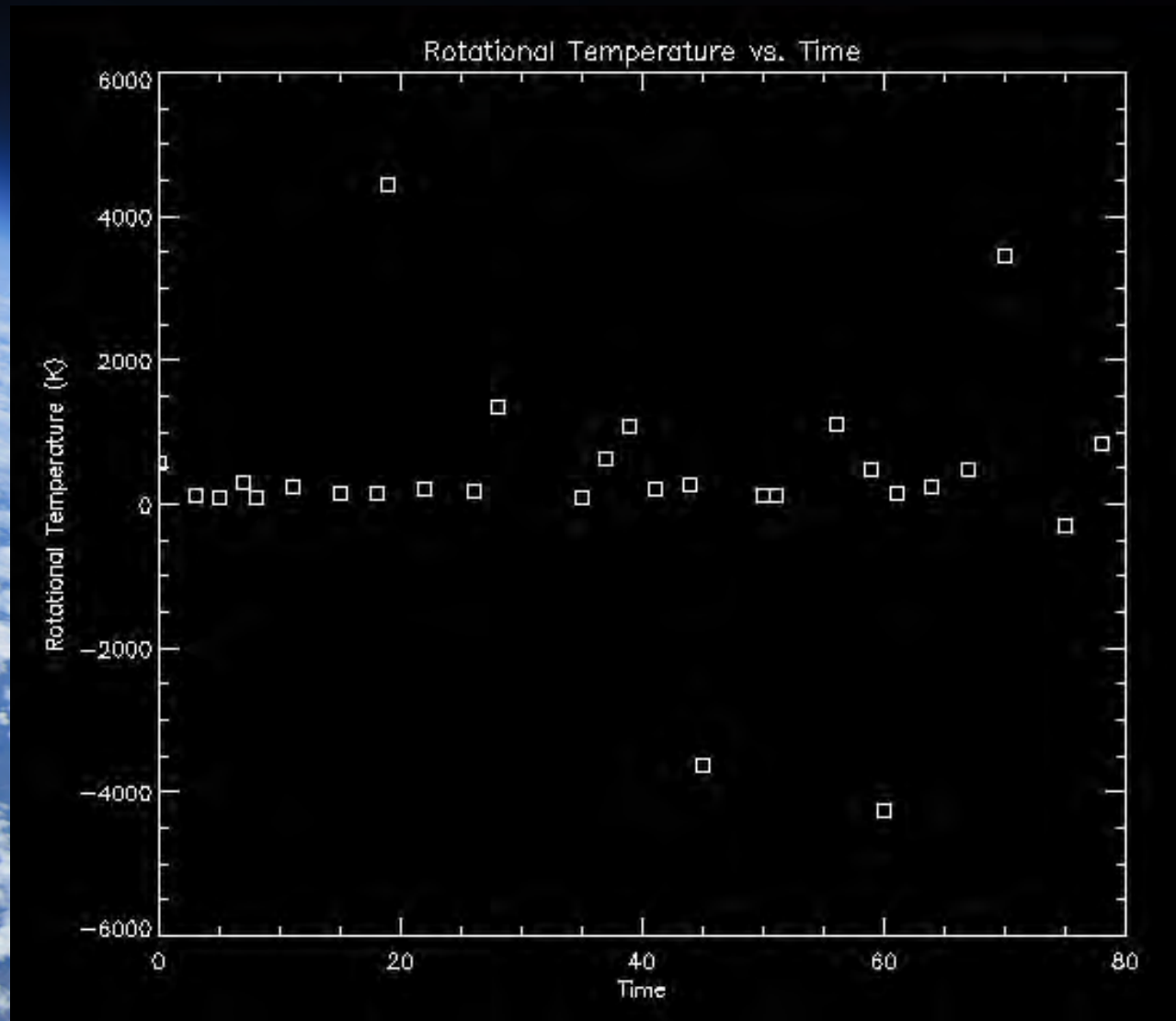
Data Filtering

- **Noisy data: Clouds and Alignment**
- **Peak intensity greater than 0**
- **Peak intensity 10x higher than average**
- **Linear pattern with negative slope**
- **Chi square value $< .05$**

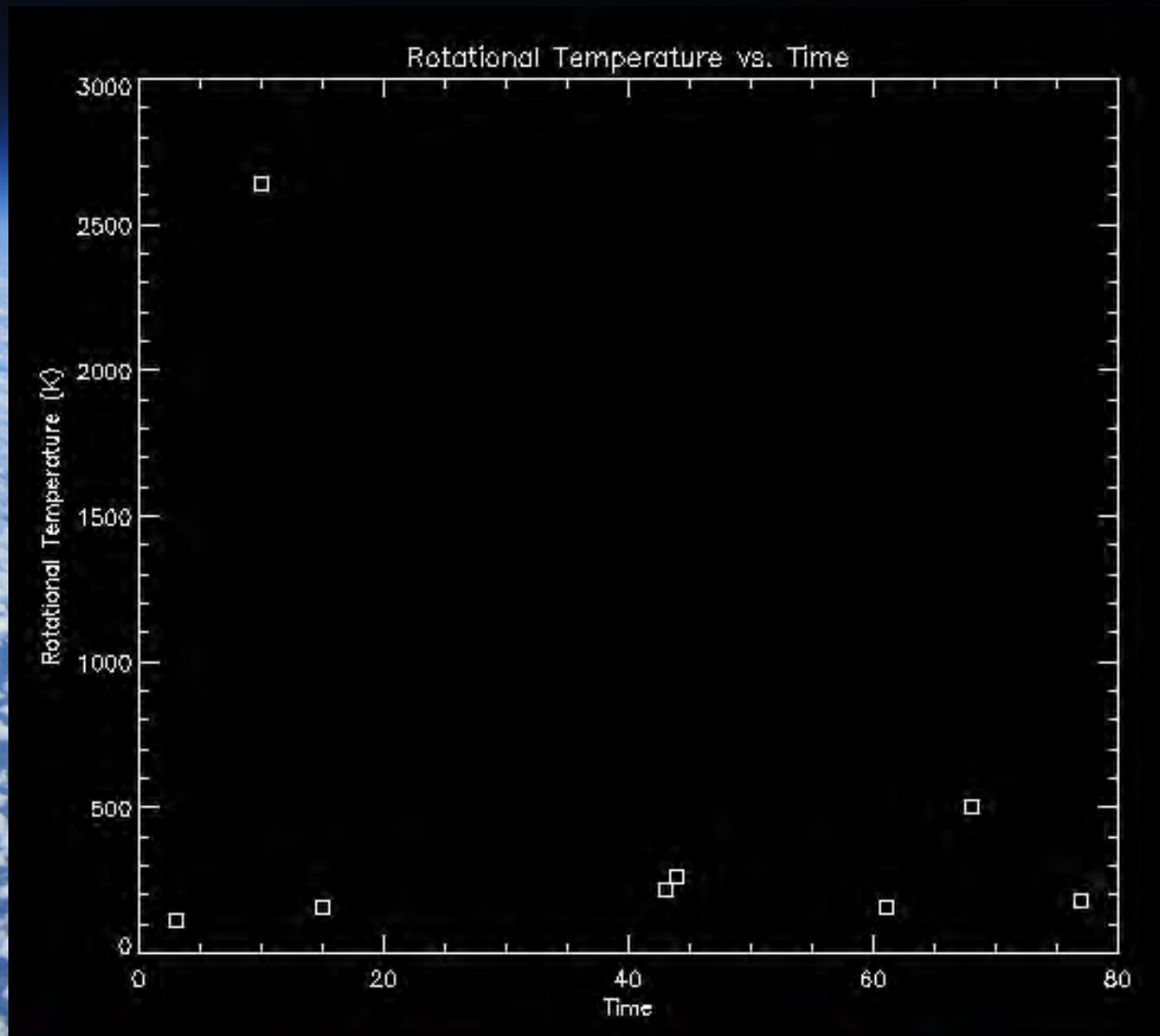
No Filtering



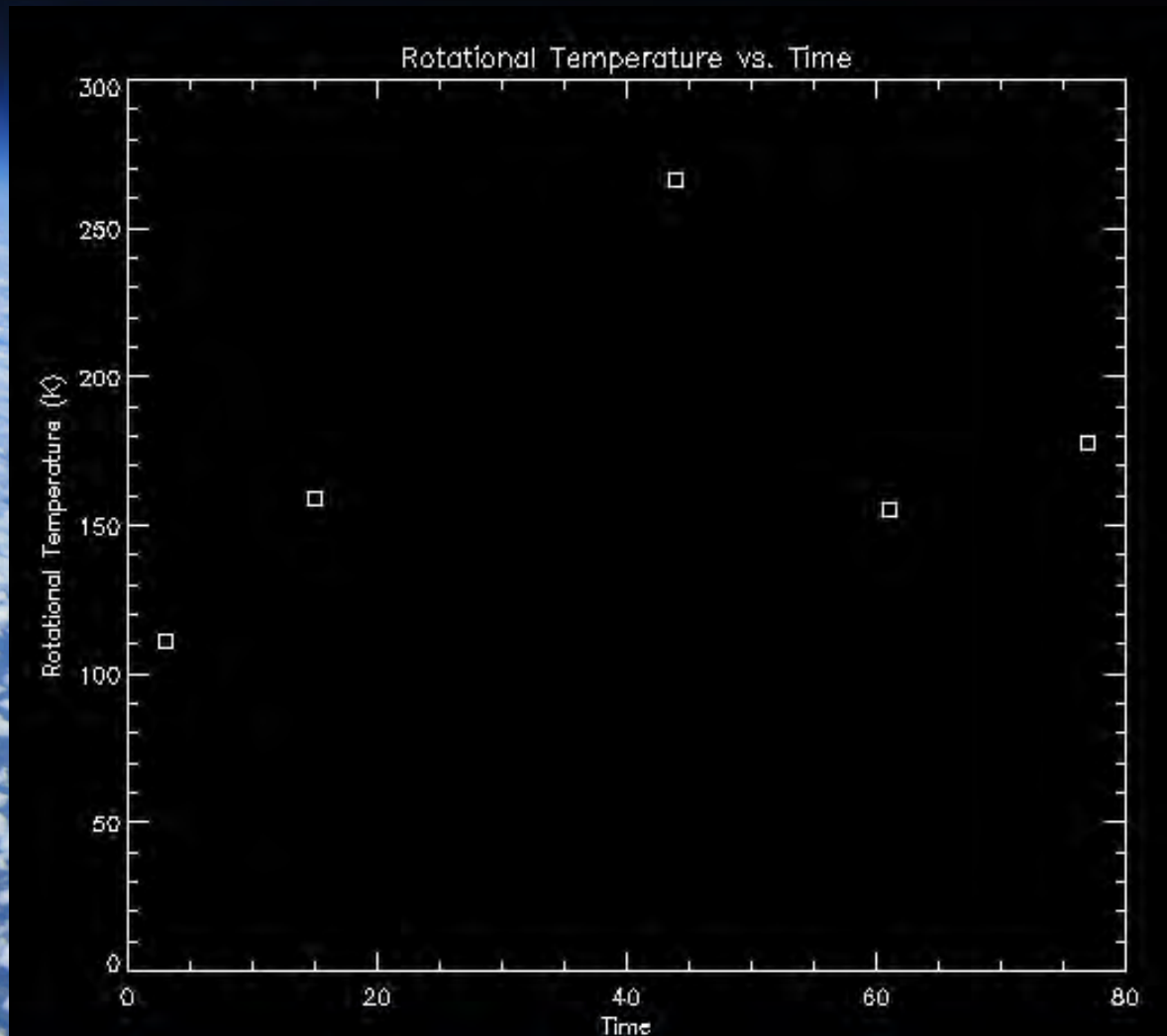
Peak Intensity Greater Than 0



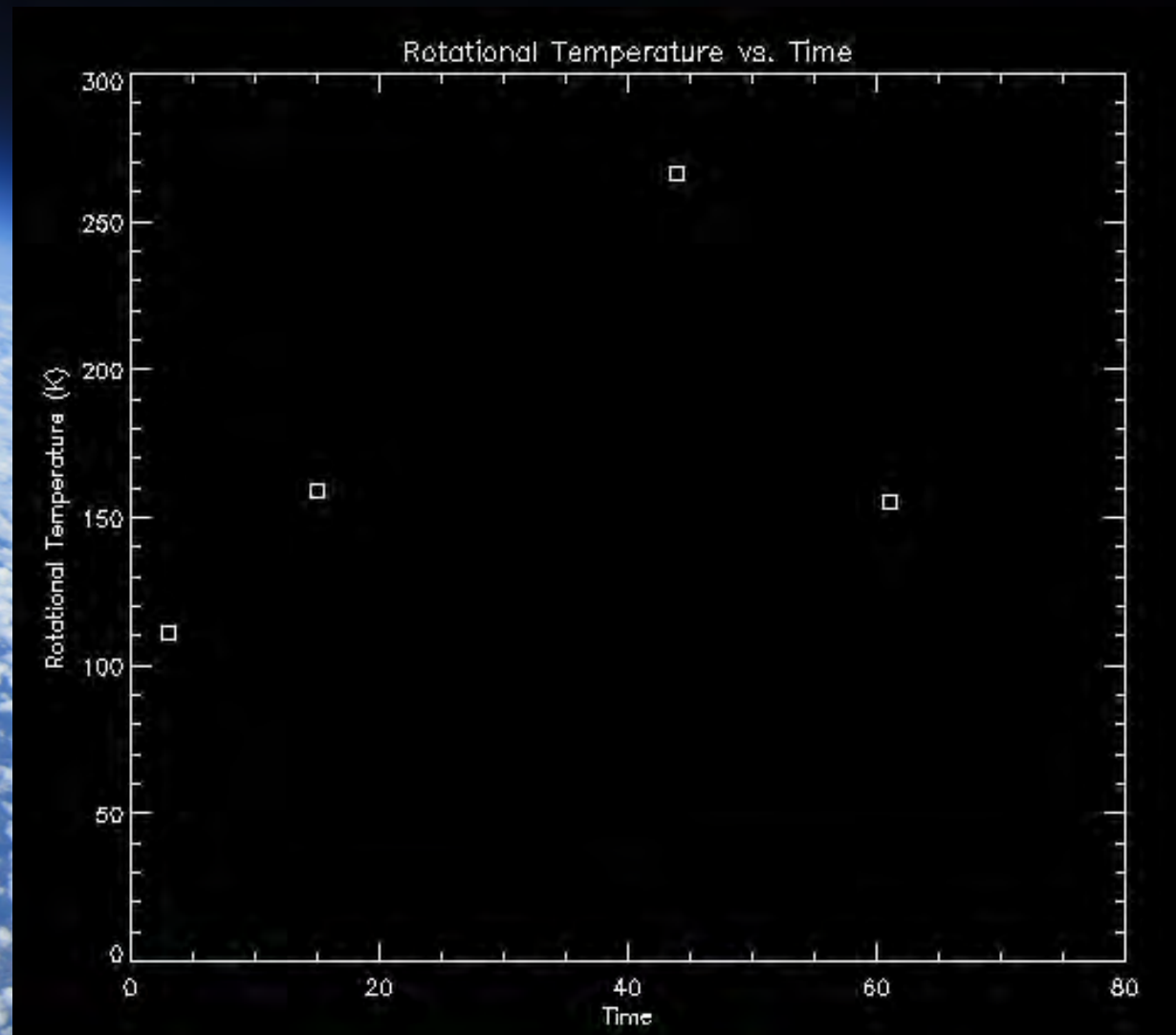
Peaks 10x Average



Linear Pattern With Negative Slope



Chi Square Value < .05



Comparison With Expected Results

- **Change in Temperature**
 - Expected: 30 K
- **Average Temperature**
 - Expected: 195 K
- **Too few valid points were found to attempt fitting a terdiurnal wave curve**

Date	Delta T (K)	Average T (K)
Jul 09-10	93.44098	350.4082
Jul 12-13	154.9807	172.7274
Jul 13-14	161.4956	403.7898
Jul 18-19	146.4787	192.8737
Jul 19-20	392.6729	279.9498

Future Study

- More nights needed for sampling
- Improve alignment method
- Longer sampling periods
- Total band intensity

Image Credits

- Background Image

Whitworth University High Altitude Ballooning

- Hydroxyl Emission Profile

D. J. Baker and A. T. Stair, Jr., *Physica Scripta*, 37,611 (1988).

- OH 3-1 Band

Application of a Michelson Interferometer to Measurements of OH Rotational Temperatures, Won *et al*, *Journal of the Korean Physical Society*, Vol. 34, No. 4, April 1999, pp.344~349

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Questions?

Thanks to all who helped me this
summer!