

Using machine learning to classify the diffuse interstellar bands

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Abstract & Introduction

Using over a million and a half extragalactic spectra from the Sloan Digital Sky Survey we study the correlations of the Diffuse Interstellar Bands (DIBs) in the Milky Way. We measure the correlation between DIB strength and dust extinction for 142 DIBs using 24 stacked spectra in the reddening range $E(B - V) < 0.2$, many more lines than ever studied before. Most of the DIBs do not correlate with dust extinction. However, we find 10 weak and barely studied DIBs with correlations that are higher than 0.7 with dust extinction and confirm the high correlation of additional 5 strong DIBs. Furthermore, we find a pair of DIBs, 5925.9 Å and 5927.5 Å, which exhibits significant negative correlation with dust extinction, indicating that their carrier may be depleted on dust. We use Machine Learning algorithms to divide the DIBs to spectroscopic families based on 250 stacked spectra. By removing the dust dependency we study how DIBs follow their local environment. We thus obtain 6 groups of weak DIBs, 4 of which are tightly associated with C₂ or CN absorption lines.

- SDSS のデータを stack して銀河系内の DIB を大きなサンプルで調査
- 142 DIBs と dust extinction の相関を調べる
 - 多くの DIB は extinction と tight な相関を見せなかった
 - dust extinction について負の相関を見せる DIB も存在した
- 197 DIBs をクラスタリング解析
 - 6 つの DIB groups が統計的に有意
 - うち 4 つは C₂ や CN と密接に関係することが示唆される

② Table 1: DIB-E(B-V)相関

E(B-V) と高い相関を示した DIB のリスト
5925.9 Å, 5927.5 Å の DIB は負の相関 (ダストに吸着?)

Table 1. DIB correlation with reddening

Wavelength[Å]	Deduced correlation
5704.7*	0.99 ± 0.50
5705.1*	0.99 ± 0.54
5779.5*	1.0 ± 0.055
5780.6*	1.0 ± 0.055
5797.1	0.87 ± 0.02
5925.9*	-0.9991 ± 0.0004
5927.5*	-0.9997 ± 0.0002
5975.6	0.72 ± 0.03
6203.2*	0.99 ± 0.30
6204.3*	0.99 ± 0.31
6280.5*	0.99 ± 0.11
6281.1*	0.99 ± 0.12
6284.3	0.976 ± 0.029
6308.9	0.762 ± 0.025
6317.6	0.841 ± 0.022
6325.1	0.713 ± 0.025
6353.5	0.839 ± 0.023
6362.4	0.702 ± 0.025
6491.9	0.808 ± 0.025
6494.2	0.904 ± 0.024
6613.7	0.801 ± 0.025
6993.2	0.704 ± 0.025
7223.1	0.706 ± 0.025
7558.2	0.777 ± 0.026
8621.1	0.841 ± 0.022

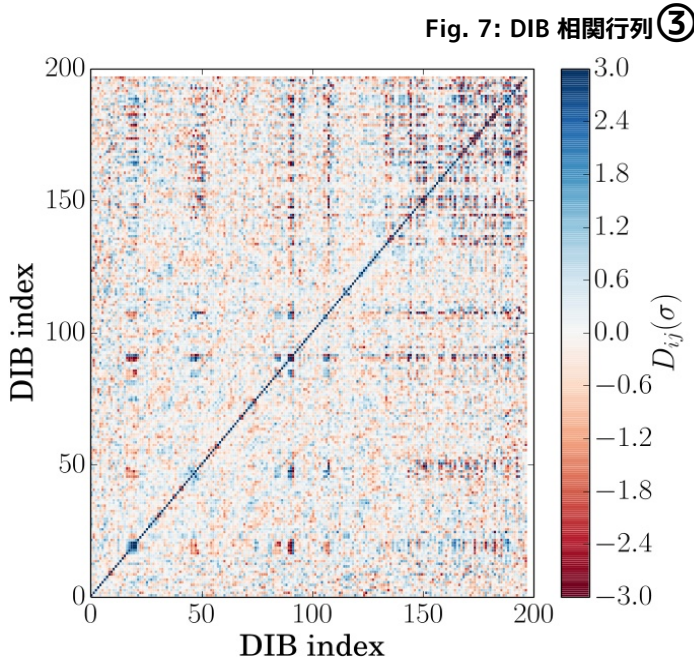
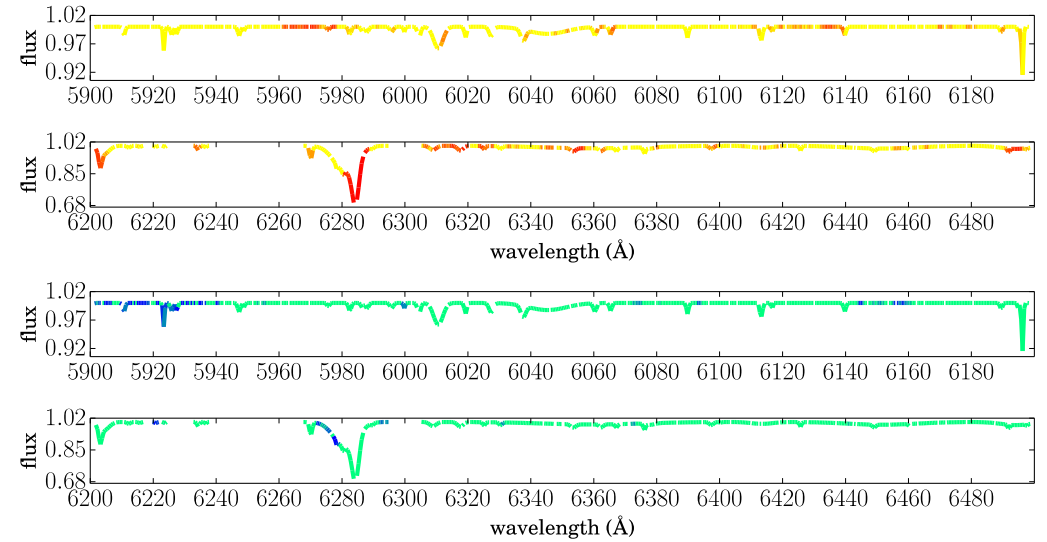


Fig. 7: DIB 相関行列 ③

① Fig. 1,3: DIB と E(B-V) の相関



全天のデータを E(B-V) の値で 24 に分割, DIB ごとに E(B-V) との相関を調べた.

各 bin は約 70,000 スペクトルのスタックで S/N ~ 240 程度.

上: Figure 1. E(B-V) と DIB 吸収が正の相関を示す波長は赤い色で示されている.

下: Figure 3. E(B-V) と DIB 吸収が負の相関を示す波長が青い色で示されている.

④ Fig. 8, Table 3,5: クラスタリング解析結果まとめ

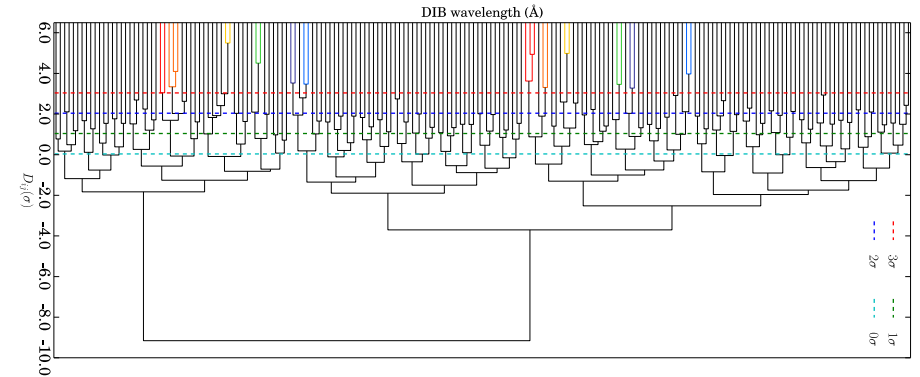


Table 3. DIBs groups for 3σ threshold

Group ID	DIBs[Å]	P(0) ^a	P(TP) ^a
3	6317.6, 6325.1	0.28	0.74
2	6497.5, 6862.5, 7569.7	0.27	0.7
4	7276.7, 8026.2	0.27	0.7
5	5927.5, 7045.6	0.28	0.66
7	5535.7, 5541.0, 5545.0	0.28	0.66
8	6330.4, 7721.0	0.23	0.64
1	7357.2, 7585.6	0.05	0.33
11	7321.1, 7832.7	0.00	0.29
6	7334.3, 7935.3	0.02	0.27
9	7099.5, 7105.9	0.00	0.14
12	6998.7, 7249.3	0.00	0.14
10	6837.7, 7562.2	0.00	0.12

Table 5. DIBs spectroscopic families and their associated molecules

DIBs [Å]	P(TP) ^a	Molecule	P(TP) ^b
6317.6, 6325.1	0.74	C2	0.74
6497.5, 6862.5, 7569.7	0.7	C2	0.65
7276.7, 8026.2	0.7	C2	0.69
5927.5, 7045.6	0.66	CN	0.57