

Semiconductor and Hall Effect

December 31, 2019

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[50]: import numpy as np
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[51]: # Importing the data collected from the LabView program for a current input 10µA  
      ↳microAmps.  
import pandas as pd  
run1= pd.read_csv('run1.txt', sep = '\s+', engine='python')  
pd.set_option('display.max_columns', None)  
pd.set_option('display.max_rows', None)  
# Length of the Ge crystal and the uncertainty,,  
d = 1.25*1e-3  
deltad = 0.01*1e-3  
run1['B-Field(Tesla)'] = run1['B-Field(Tesla)']/10000  
inverseTemp = [1000/run1.iloc[x]['Temperature(K)'] for x in range(run1.shape[0])]  
run1['1000/T(1/K)'] = inverseTemp  
run1
```

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[51]:
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	Temperature(K)	B-Field(Tesla)	I_AB	I_AD	I_AC	I_BD	\
0	96.040	0.531700	0.00001	0.00001	0.00001	0.00001	
1	97.410	0.011890	0.00001	0.00001	0.00001	0.00001	
2	98.640	-0.516800	0.00001	0.00001	0.00001	0.00001	
3	100.280	0.531700	0.00001	0.00001	0.00001	0.00001	
4	101.650	0.011915	0.00001	0.00001	0.00001	0.00001	
5	102.910	-0.516500	0.00001	0.00001	0.00001	0.00001	
6	104.600	0.531500	0.00001	0.00001	0.00001	0.00001	
7	106.055	0.011880	0.00001	0.00001	0.00001	0.00001	
8	107.330	-0.516400	0.00001	0.00001	0.00001	0.00001	
9	108.880	0.531500	0.00001	0.00001	0.00001	0.00001	
10	110.145	0.011887	0.00001	0.00001	0.00001	0.00001	
11	111.405	-0.516300	0.00001	0.00001	0.00001	0.00001	
12	113.010	0.531400	0.00001	0.00001	0.00001	0.00001	
13	114.305	0.011895	0.00001	0.00001	0.00001	0.00001	
14	115.670	-0.516100	0.00001	0.00001	0.00001	0.00001	
15	117.455	0.531300	0.00001	0.00001	0.00001	0.00001	
16	118.740	0.011895	0.00001	0.00001	0.00001	0.00001	
17	120.000	-0.516100	0.00001	0.00001	0.00001	0.00001	
18	121.775	0.531100	0.00001	0.00001	0.00001	0.00001	
19	123.050	0.011886	0.00001	0.00001	0.00001	0.00001	

20	124.315	-0.515900	0.00001	0.00001	0.00001	0.00001
21	125.880	0.531100	0.00001	0.00001	0.00001	0.00001
22	127.330	0.011884	0.00001	0.00001	0.00001	0.00001
23	128.640	-0.515800	0.00001	0.00001	0.00001	0.00001
24	130.195	0.531000	0.00001	0.00001	0.00001	0.00001
25	131.435	0.011859	0.00001	0.00001	0.00001	0.00001
26	132.725	-0.515800	0.00001	0.00001	0.00001	0.00001
27	134.310	0.530900	0.00001	0.00001	0.00001	0.00001
28	135.735	0.011864	0.00001	0.00001	0.00001	0.00001
29	136.995	-0.515600	0.00001	0.00001	0.00001	0.00001
30	138.615	0.530800	0.00001	0.00001	0.00001	0.00001
31	139.905	0.011883	0.00001	0.00001	0.00001	0.00001
32	141.185	-0.515500	0.00001	0.00001	0.00001	0.00001
33	142.860	0.530700	0.00001	0.00001	0.00001	0.00001
34	144.295	0.011865	0.00001	0.00001	0.00001	0.00001
35	145.685	-0.515500	0.00001	0.00001	0.00001	0.00001
36	147.350	0.530600	0.00001	0.00001	0.00001	0.00001
37	148.680	0.011883	0.00001	0.00001	0.00001	0.00001
38	150.090	-0.515400	0.00001	0.00001	0.00001	0.00001
39	151.765	0.530600	0.00001	0.00001	0.00001	0.00001
40	153.130	0.011873	0.00001	0.00001	0.00001	0.00001
41	154.455	-0.515300	0.00001	0.00001	0.00001	0.00001
42	156.175	0.530500	0.00001	0.00001	0.00001	0.00001
43	157.590	0.011867	0.00001	0.00001	0.00001	0.00001
44	158.870	-0.515300	0.00001	0.00001	0.00001	0.00001
45	160.535	0.530500	0.00001	0.00001	0.00001	0.00001
46	161.835	0.011877	0.00001	0.00001	0.00001	0.00001
47	163.150	-0.515300	0.00001	0.00001	0.00001	0.00001
48	164.875	0.530600	0.00001	0.00001	0.00001	0.00001
49	166.165	0.011865	0.00001	0.00001	0.00001	0.00001
50	167.465	-0.515200	0.00001	0.00001	0.00001	0.00001
51	169.185	0.530500	0.00001	0.00001	0.00001	0.00001
52	170.575	0.011869	0.00001	0.00001	0.00001	0.00001
53	172.000	-0.515200	0.00001	0.00001	0.00001	0.00001
54	173.625	0.530500	0.00001	0.00001	0.00001	0.00001
55	175.080	0.011898	0.00001	0.00001	0.00001	0.00001
56	176.375	-0.515200	0.00001	0.00001	0.00001	0.00001
57	178.010	0.530400	0.00001	0.00001	0.00001	0.00001
58	179.390	0.011881	0.00001	0.00001	0.00001	0.00001
59	180.675	-0.515100	0.00001	0.00001	0.00001	0.00001
60	182.285	0.530300	0.00001	0.00001	0.00001	0.00001
61	183.700	0.011883	0.00001	0.00001	0.00001	0.00001
62	185.095	-0.515100	0.00001	0.00001	0.00001	0.00001
63	186.690	0.530400	0.00001	0.00001	0.00001	0.00001
64	188.105	0.011896	0.00001	0.00001	0.00001	0.00001
65	189.485	-0.515100	0.00001	0.00001	0.00001	0.00001
66	191.070	0.530400	0.00001	0.00001	0.00001	0.00001

67	192.375	0.011868	0.00001	0.00001	0.00001	0.00001
68	193.685	-0.515000	0.00001	0.00001	0.00001	0.00001
69	195.345	0.530300	0.00001	0.00001	0.00001	0.00001
70	196.685	0.011888	0.00001	0.00001	0.00001	0.00001
71	198.040	-0.515000	0.00001	0.00001	0.00001	0.00001
72	199.940	0.530300	0.00001	0.00001	0.00001	0.00001
73	201.450	0.011879	0.00001	0.00001	0.00001	0.00001
74	202.900	-0.515000	0.00001	0.00001	0.00001	0.00001
75	204.650	0.530400	0.00001	0.00001	0.00001	0.00001
76	206.200	0.011856	0.00001	0.00001	0.00001	0.00001
77	207.700	-0.515000	0.00001	0.00001	0.00001	0.00001
78	209.400	0.530400	0.00001	0.00001	0.00001	0.00001
79	210.750	0.011897	0.00001	0.00001	0.00001	0.00001
80	212.000	-0.515000	0.00001	0.00001	0.00001	0.00001
81	213.650	0.530300	0.00001	0.00001	0.00001	0.00001
82	215.100	0.011870	0.00001	0.00001	0.00001	0.00001
83	216.600	-0.515000	0.00001	0.00001	0.00001	0.00001
84	218.400	0.530300	0.00001	0.00001	0.00001	0.00001
85	219.950	0.011898	0.00001	0.00001	0.00001	0.00001
86	221.500	-0.515000	0.00001	0.00001	0.00001	0.00001
87	223.250	0.530300	0.00001	0.00001	0.00001	0.00001
88	224.700	0.011885	0.00001	0.00001	0.00001	0.00001
89	226.200	-0.515000	0.00001	0.00001	0.00001	0.00001
90	228.050	0.530300	0.00001	0.00001	0.00001	0.00001
91	229.550	0.011868	0.00001	0.00001	0.00001	0.00001
92	231.000	-0.514900	0.00001	0.00001	0.00001	0.00001
93	232.750	0.530300	0.00001	0.00001	0.00001	0.00001
94	234.300	0.011862	0.00001	0.00001	0.00001	0.00001
95	235.750	-0.514900	0.00001	0.00001	0.00001	0.00001
96	237.550	0.530300	0.00001	0.00001	0.00001	0.00001
97	239.050	0.011886	0.00001	0.00001	0.00001	0.00001
98	240.500	-0.515000	0.00001	0.00001	0.00001	0.00001
99	242.300	0.530300	0.00001	0.00001	0.00001	0.00001
100	243.750	0.011887	0.00001	0.00001	0.00001	0.00001
101	245.250	-0.514900	0.00001	0.00001	0.00001	0.00001
102	247.100	0.530400	0.00001	0.00001	0.00001	0.00001
103	248.600	0.011884	0.00001	0.00001	0.00001	0.00001
104	250.250	-0.514900	0.00001	0.00001	0.00001	0.00001
105	252.100	0.530400	0.00001	0.00001	0.00001	0.00001
106	253.600	0.011882	0.00001	0.00001	0.00001	0.00001
107	255.100	-0.514900	0.00001	0.00001	0.00001	0.00001
108	256.950	0.530300	0.00001	0.00001	0.00001	0.00001
109	258.450	0.011872	0.00001	0.00001	0.00001	0.00001
110	259.900	-0.514900	0.00001	0.00001	0.00001	0.00001
111	261.750	0.530300	0.00001	0.00001	0.00001	0.00001
112	263.250	0.011865	0.00001	0.00001	0.00001	0.00001
113	264.750	-0.514900	0.00001	0.00001	0.00001	0.00001

114	266.550	0.530300	0.00001	0.00001	0.00001	0.00001
115	268.050	0.011881	0.00001	0.00001	0.00001	0.00001
116	269.550	-0.514800	0.00001	0.00001	0.00001	0.00001
117	271.300	0.530300	0.00001	0.00001	0.00001	0.00001
118	272.800	0.011885	0.00001	0.00001	0.00001	0.00001
119	274.300	-0.514800	0.00001	0.00001	0.00001	0.00001
120	276.100	0.530200	0.00001	0.00001	0.00001	0.00001
121	277.600	0.011875	0.00001	0.00001	0.00001	0.00001
122	279.100	-0.514800	0.00001	0.00001	0.00001	0.00001
123	280.850	0.530200	0.00001	0.00001	0.00001	0.00001
124	282.400	0.011866	0.00001	0.00001	0.00001	0.00001
125	283.900	-0.514900	0.00001	0.00001	0.00001	0.00001
126	285.650	0.530300	0.00001	0.00001	0.00001	0.00001
127	287.150	0.011875	0.00001	0.00001	0.00001	0.00001
128	288.650	-0.514800	0.00001	0.00001	0.00001	0.00001
129	290.450	0.530300	0.00001	0.00001	0.00001	0.00001
130	291.950	0.011865	0.00001	0.00001	0.00001	0.00001
131	293.450	-0.514800	0.00001	0.00001	0.00001	0.00001
132	295.350	0.530200	0.00001	0.00001	0.00001	0.00001
133	296.850	0.011864	0.00001	0.00001	0.00001	0.00001
134	298.300	-0.514800	0.00001	0.00001	0.00001	0.00001
135	300.150	0.530200	0.00001	0.00001	0.00001	0.00001
136	301.600	0.011883	0.00001	0.00001	0.00001	0.00001
137	303.150	-0.514800	0.00001	0.00001	0.00001	0.00001
138	304.950	0.530200	0.00001	0.00001	0.00001	0.00001
139	306.450	0.011880	0.00001	0.00001	0.00001	0.00001
140	307.950	-0.514700	0.00001	0.00001	0.00001	0.00001
141	309.800	0.530200	0.00001	0.00001	0.00001	0.00001
142	311.300	0.011875	0.00001	0.00001	0.00001	0.00001
143	312.850	-0.514700	0.00001	0.00001	0.00001	0.00001
144	314.700	0.530300	0.00001	0.00001	0.00001	0.00001
145	316.300	0.011893	0.00001	0.00001	0.00001	0.00001
146	317.800	-0.514700	0.00001	0.00001	0.00001	0.00001
147	319.650	0.530200	0.00001	0.00001	0.00001	0.00001
148	321.150	0.011867	0.00001	0.00001	0.00001	0.00001
149	322.700	-0.514700	0.00001	0.00001	0.00001	0.00001
150	324.500	0.530200	0.00001	0.00001	0.00001	0.00001
151	326.000	0.011873	0.00001	0.00001	0.00001	0.00001
152	327.250	-0.514600	0.00001	0.00001	0.00001	0.00001
153	328.800	0.530200	0.00001	0.00001	0.00001	0.00001
154	330.150	0.011868	0.00001	0.00001	0.00001	0.00001
155	331.450	-0.514700	0.00001	0.00001	0.00001	0.00001
156	333.150	0.530200	0.00001	0.00001	0.00001	0.00001
157	334.600	0.011883	0.00001	0.00001	0.00001	0.00001
158	336.100	-0.514700	0.00001	0.00001	0.00001	0.00001
159	337.850	0.530100	0.00001	0.00001	0.00001	0.00001
160	339.300	0.011881	0.00001	0.00001	0.00001	0.00001

161	340.800	-0.514700	0.00001	0.00001	0.00001	0.00001
162	342.600	0.530200	0.00001	0.00001	0.00001	0.00001
163	344.100	0.011885	0.00001	0.00001	0.00001	0.00001
164	345.600	-0.514700	0.00001	0.00001	0.00001	0.00001
165	347.400	0.530100	0.00001	0.00001	0.00001	0.00001
166	348.900	0.011869	0.00001	0.00001	0.00001	0.00001
167	350.400	-0.514700	0.00001	0.00001	0.00001	0.00001

	I_-AB	I_-AD	I_-AC	I_-BD	V_CD	V_BC	V_BD	\
0	-0.00001	-0.00001	-0.00001	-0.00001	-0.002760	0.003342	0.011449	
1	-0.00001	-0.00001	-0.00001	-0.00001	0.001836	0.001967	-0.000075	
2	-0.00001	-0.00001	-0.00001	-0.00001	0.002935	0.002987	-0.011368	
3	-0.00001	-0.00001	-0.00001	-0.00001	0.002909	0.003561	0.011538	
4	-0.00001	-0.00001	-0.00001	-0.00001	0.001979	0.002138	-0.000045	
5	-0.00001	-0.00001	-0.00001	-0.00001	0.003125	0.003210	-0.011376	
6	-0.00001	-0.00001	-0.00001	-0.00001	0.003110	0.003805	0.011631	
7	-0.00001	-0.00001	-0.00001	-0.00001	0.002137	0.002326	-0.000010	
8	-0.00001	-0.00001	-0.00001	-0.00001	0.003343	0.003468	-0.011369	
9	-0.00001	-0.00001	-0.00001	-0.00001	0.003328	0.004069	0.011716	
10	-0.00001	-0.00001	-0.00001	-0.00001	0.002303	0.002520	0.000017	
11	-0.00001	-0.00001	-0.00001	-0.00001	0.003551	0.003713	-0.011375	
12	-0.00001	-0.00001	-0.00001	-0.00001	0.003536	0.004322	0.011800	
13	-0.00001	-0.00001	-0.00001	-0.00001	0.002477	0.002723	0.000047	
14	-0.00001	-0.00001	-0.00001	-0.00001	0.003766	0.003971	-0.011378	
15	-0.00001	-0.00001	-0.00001	-0.00001	0.003770	0.004606	0.011881	
16	-0.00001	-0.00001	-0.00001	-0.00001	0.002673	0.002955	0.000080	
17	-0.00001	-0.00001	-0.00001	-0.00001	0.004016	0.004256	-0.011377	
18	-0.00001	-0.00001	-0.00001	-0.00001	0.004018	0.004905	0.011979	
19	-0.00001	-0.00001	-0.00001	-0.00001	0.002876	0.003195	0.000121	
20	-0.00001	-0.00001	-0.00001	-0.00001	0.004261	0.004553	-0.011369	
21	-0.00001	-0.00001	-0.00001	-0.00001	0.004255	0.005194	0.012062	
22	-0.00001	-0.00001	-0.00001	-0.00001	0.003080	0.003439	0.000159	
23	-0.00001	-0.00001	-0.00001	-0.00001	0.004520	0.004860	-0.011359	
24	-0.00001	-0.00001	-0.00001	-0.00001	0.004518	0.005513	0.012151	
25	-0.00001	-0.00001	-0.00001	-0.00001	0.003300	0.003695	0.000196	
26	-0.00001	-0.00001	-0.00001	-0.00001	0.004783	0.005165	-0.011343	
27	-0.00001	-0.00001	-0.00001	-0.00001	0.004781	0.005834	0.012242	
28	-0.00001	-0.00001	-0.00001	-0.00001	0.003530	0.003976	0.000244	
29	-0.00001	-0.00001	-0.00001	-0.00001	0.005056	0.005493	-0.011329	
30	-0.00001	-0.00001	-0.00001	-0.00001	0.005061	0.006170	0.012338	
31	-0.00001	-0.00001	-0.00001	-0.00001	0.003766	0.004258	0.000292	
32	-0.00001	-0.00001	-0.00001	-0.00001	0.005338	0.005825	-0.011308	
33	-0.00001	-0.00001	-0.00001	-0.00001	0.005348	0.006519	0.012440	
34	-0.00001	-0.00001	-0.00001	-0.00001	0.004023	0.004567	0.000350	
35	-0.00001	-0.00001	-0.00001	-0.00001	0.005647	0.006201	-0.011281	
36	-0.00001	-0.00001	-0.00001	-0.00001	0.005665	0.006909	0.012553	
37	-0.00001	-0.00001	-0.00001	-0.00001	0.004301	0.004905	0.000405	

38	-0.00001	-0.00001	-0.00001	-0.00001	0.005971	0.006594	-0.011253
39	-0.00001	-0.00001	-0.00001	-0.00001	0.005994	0.007319	0.012676
40	-0.00001	-0.00001	-0.00001	-0.00001	0.004601	0.005269	0.000478
41	-0.00001	-0.00001	-0.00001	-0.00001	0.006302	0.006995	-0.011228
42	-0.00001	-0.00001	-0.00001	-0.00001	0.006315	0.007707	0.012785
43	-0.00001	-0.00001	-0.00001	-0.00001	0.004884	0.005612	0.000535
44	-0.00001	-0.00001	-0.00001	-0.00001	0.006611	0.007362	-0.011207
45	-0.00001	-0.00001	-0.00001	-0.00001	0.006617	0.008078	0.012895
46	-0.00001	-0.00001	-0.00001	-0.00001	0.005143	0.005930	0.000592
47	-0.00001	-0.00001	-0.00001	-0.00001	0.006895	0.007710	-0.011181
48	-0.00001	-0.00001	-0.00001	-0.00001	0.006910	0.008444	0.013007
49	-0.00001	-0.00001	-0.00001	-0.00001	0.005417	0.006268	0.000661
50	-0.00001	-0.00001	-0.00001	-0.00001	0.007198	0.008089	-0.011147
51	-0.00001	-0.00001	-0.00001	-0.00001	0.007218	0.008838	0.013135
52	-0.00001	-0.00001	-0.00001	-0.00001	0.005717	0.006640	0.000736
53	-0.00001	-0.00001	-0.00001	-0.00001	0.007548	0.008518	-0.011113
54	-0.00001	-0.00001	-0.00001	-0.00001	0.007563	0.009269	0.013271
55	-0.00001	-0.00001	-0.00001	-0.00001	0.006054	0.007056	0.000812
56	-0.00001	-0.00001	-0.00001	-0.00001	0.007918	0.008969	-0.011085
57	-0.00001	-0.00001	-0.00001	-0.00001	0.007950	0.009738	0.013412
58	-0.00001	-0.00001	-0.00001	-0.00001	0.006410	0.007487	0.000887
59	-0.00001	-0.00001	-0.00001	-0.00001	0.008305	0.009433	-0.011058
60	-0.00001	-0.00001	-0.00001	-0.00001	0.008331	0.010209	0.013549
61	-0.00001	-0.00001	-0.00001	-0.00001	0.006776	0.007928	0.000960
62	-0.00001	-0.00001	-0.00001	-0.00001	0.008709	0.009925	-0.011040
63	-0.00001	-0.00001	-0.00001	-0.00001	0.008744	0.010710	0.013699
64	-0.00001	-0.00001	-0.00001	-0.00001	0.007161	0.008400	0.001054
65	-0.00001	-0.00001	-0.00001	-0.00001	0.009120	0.010417	-0.011019
66	-0.00001	-0.00001	-0.00001	-0.00001	0.009165	0.011219	0.013853
67	-0.00001	-0.00001	-0.00001	-0.00001	0.007561	0.008880	0.001130
68	-0.00001	-0.00001	-0.00001	-0.00001	0.009533	0.010912	-0.010994
69	-0.00001	-0.00001	-0.00001	-0.00001	0.009588	0.011727	0.014001
70	-0.00001	-0.00001	-0.00001	-0.00001	0.007966	0.009373	0.001214
71	-0.00001	-0.00001	-0.00001	-0.00001	0.009962	0.011422	-0.010973
72	-0.00001	-0.00001	-0.00001	-0.00001	0.010045	0.012276	0.014163
73	-0.00001	-0.00001	-0.00001	-0.00001	0.008427	0.009918	0.001309
74	-0.00001	-0.00001	-0.00001	-0.00001	0.010458	0.012009	-0.010958
75	-0.00001	-0.00001	-0.00001	-0.00001	0.010532	0.012856	0.014316
76	-0.00001	-0.00001	-0.00001	-0.00001	0.008905	0.010487	0.001397
77	-0.00001	-0.00001	-0.00001	-0.00001	0.010960	0.012598	-0.010938
78	-0.00001	-0.00001	-0.00001	-0.00001	0.011058	0.013455	0.014460
79	-0.00001	-0.00001	-0.00001	-0.00001	0.009394	0.011042	0.001469
80	-0.00001	-0.00001	-0.00001	-0.00001	0.011445	0.013140	-0.010941
81	-0.00001	-0.00001	-0.00001	-0.00001	0.011527	0.013969	0.014552
82	-0.00001	-0.00001	-0.00001	-0.00001	0.009864	0.011575	0.001525
83	-0.00001	-0.00001	-0.00001	-0.00001	0.011934	0.013685	-0.010936
84	-0.00001	-0.00001	-0.00001	-0.00001	0.012063	0.014545	0.014643

85	-0.00001	-0.00001	-0.00001	-0.00001	0.010365	0.012142	0.001597
86	-0.00001	-0.00001	-0.00001	-0.00001	0.012433	0.014237	-0.010904
87	-0.00001	-0.00001	-0.00001	-0.00001	0.012512	0.015089	0.014745
88	-0.00001	-0.00001	-0.00001	-0.00001	0.010802	0.012683	0.001694
89	-0.00001	-0.00001	-0.00001	-0.00001	0.012894	0.014772	-0.010833
90	-0.00001	-0.00001	-0.00001	-0.00001	0.013116	0.015662	0.014690
91	-0.00001	-0.00001	-0.00001	-0.00001	0.011368	0.013255	0.001697
92	-0.00001	-0.00001	-0.00001	-0.00001	0.013454	0.015319	-0.010764
93	-0.00001	-0.00001	-0.00001	-0.00001	0.013682	0.016163	0.014502
94	-0.00001	-0.00001	-0.00001	-0.00001	0.011895	0.013754	0.001674
95	-0.00001	-0.00001	-0.00001	-0.00001	0.013957	0.015792	-0.010557
96	-0.00001	-0.00001	-0.00001	-0.00001	0.014176	0.016564	0.014076
97	-0.00001	-0.00001	-0.00001	-0.00001	0.012328	0.014137	0.001622
98	-0.00001	-0.00001	-0.00001	-0.00001	0.014327	0.016110	-0.010081
99	-0.00001	-0.00001	-0.00001	-0.00001	0.014507	0.016749	0.013258
100	-0.00001	-0.00001	-0.00001	-0.00001	0.012578	0.014319	0.001556
101	-0.00001	-0.00001	-0.00001	-0.00001	0.014445	0.016175	-0.009097
102	-0.00001	-0.00001	-0.00001	-0.00001	0.014488	0.016548	0.011771
103	-0.00001	-0.00001	-0.00001	-0.00001	0.012451	0.014107	0.001469
104	-0.00001	-0.00001	-0.00001	-0.00001	0.014057	0.015724	-0.007262
105	-0.00001	-0.00001	-0.00001	-0.00001	0.013823	0.015667	0.009376
106	-0.00001	-0.00001	-0.00001	-0.00001	0.011685	0.013216	0.001351
107	-0.00001	-0.00001	-0.00001	-0.00001	0.012943	0.014543	-0.004719
108	-0.00001	-0.00001	-0.00001	-0.00001	0.012391	0.014013	0.006435
109	-0.00001	-0.00001	-0.00001	-0.00001	0.010282	0.011672	0.001196
110	-0.00001	-0.00001	-0.00001	-0.00001	0.011131	0.012600	-0.002084
111	-0.00001	-0.00001	-0.00001	-0.00001	0.010358	0.011748	0.003594
112	-0.00001	-0.00001	-0.00001	-0.00001	0.008474	0.009669	0.000996
113	-0.00001	-0.00001	-0.00001	-0.00001	0.008968	0.010226	-0.000107
114	-0.00001	-0.00001	-0.00001	-0.00001	0.008156	0.009295	0.001502
115	-0.00001	-0.00001	-0.00001	-0.00001	0.006636	0.007608	0.000771
116	-0.00001	-0.00001	-0.00001	-0.00001	0.006882	0.007902	0.000926
117	-0.00001	-0.00001	-0.00001	-0.00001	0.006185	0.007076	0.000283
118	-0.00001	-0.00001	-0.00001	-0.00001	0.005039	0.005807	0.000553
119	-0.00001	-0.00001	-0.00001	-0.00001	0.005157	0.005947	0.001254
120	-0.00001	-0.00001	-0.00001	-0.00001	0.004611	0.005296	-0.000302
121	-0.00001	-0.00001	-0.00001	-0.00001	0.003777	0.004366	0.000367
122	-0.00001	-0.00001	-0.00001	-0.00001	0.003822	0.004425	0.001209
123	-0.00001	-0.00001	-0.00001	-0.00001	0.003425	0.003936	-0.000527
124	-0.00001	-0.00001	-0.00001	-0.00001	0.002822	0.003265	0.000224
125	-0.00001	-0.00001	-0.00001	-0.00001	0.002827	0.003289	0.001023
126	-0.00001	-0.00001	-0.00001	-0.00001	0.002532	0.002915	-0.000588
127	-0.00001	-0.00001	-0.00001	-0.00001	0.002103	0.002443	0.000116
128	-0.00001	-0.00001	-0.00001	-0.00001	0.002094	0.002443	0.000810
129	-0.00001	-0.00001	-0.00001	-0.00001	0.001881	0.002167	-0.000574
130	-0.00001	-0.00001	-0.00001	-0.00001	0.001563	0.001824	0.000032
131	-0.00001	-0.00001	-0.00001	-0.00001	0.001553	0.001825	0.000615

132	-0.00001	-0.00001	-0.00001	-0.00001	0.001388	0.001604	-0.000535
133	-0.00001	-0.00001	-0.00001	-0.00001	0.001152	0.001351	-0.000035
134	-0.00001	-0.00001	-0.00001	-0.00001	0.001142	0.001349	0.000439
135	-0.00001	-0.00001	-0.00001	-0.00001	0.001030	0.001192	-0.000483
136	-0.00001	-0.00001	-0.00001	-0.00001	0.000857	0.001005	-0.000077
137	-0.00001	-0.00001	-0.00001	-0.00001	0.000840	0.000996	0.000305
138	-0.00001	-0.00001	-0.00001	-0.00001	0.000761	0.000883	-0.000441
139	-0.00001	-0.00001	-0.00001	-0.00001	0.000624	0.000743	-0.000110
140	-0.00001	-0.00001	-0.00001	-0.00001	0.000608	0.000736	0.000193
141	-0.00001	-0.00001	-0.00001	-0.00001	0.000547	0.000638	-0.000399
142	-0.00001	-0.00001	-0.00001	-0.00001	0.000445	0.000532	-0.000138
143	-0.00001	-0.00001	-0.00001	-0.00001	0.000425	0.000525	0.000104
144	-0.00001	-0.00001	-0.00001	-0.00001	0.000383	0.000450	0.000000
145	-0.00001	-0.00001	-0.00001	-0.00001	0.000302	0.000371	-0.000155
146	-0.00001	-0.00001	-0.00001	-0.00001	0.000289	0.000363	0.000037
147	-0.00001	-0.00001	-0.00001	-0.00001	0.000260	0.000310	-0.000344
148	-0.00001	-0.00001	-0.00001	-0.00001	0.000197	0.000247	-0.000174
149	-0.00001	-0.00001	-0.00001	-0.00001	0.000179	0.000240	-0.000014
150	-0.00001	-0.00001	-0.00001	-0.00001	0.000162	0.000192	-0.000326
151	-0.00001	-0.00001	-0.00001	-0.00001	0.000109	0.000151	-0.000182
152	-0.00001	-0.00001	-0.00001	-0.00001	0.000099	0.000149	-0.000058
153	-0.00001	-0.00001	-0.00001	-0.00001	0.000089	0.000116	-0.000314
154	-0.00001	-0.00001	-0.00001	-0.00001	0.000056	0.000091	-0.000190
155	-0.00001	-0.00001	-0.00001	-0.00001	0.000046	0.000081	-0.000087
156	-0.00001	-0.00001	-0.00001	-0.00001	0.000039	0.000053	-0.000307
157	-0.00001	-0.00001	-0.00001	-0.00001	0.000003	0.000025	-0.000207
158	-0.00001	-0.00001	-0.00001	-0.00001	-0.000004	0.000022	-0.000115
159	-0.00001	-0.00001	-0.00001	-0.00001	-0.000007	-0.000005	-0.000295
160	-0.00001	-0.00001	-0.00001	-0.00001	-0.000038	-0.000027	-0.000212
161	-0.00001	-0.00001	-0.00001	-0.00001	-0.000048	-0.000030	-0.000137
162	-0.00001	-0.00001	-0.00001	-0.00001	-0.000049	-0.000051	-0.000292
163	-0.00001	-0.00001	-0.00001	-0.00001	-0.000079	-0.000071	-0.000219
164	-0.00001	-0.00001	-0.00001	-0.00001	-0.000091	-0.000076	-0.000156
165	-0.00001	-0.00001	-0.00001	-0.00001	-0.000080	-0.000094	-0.000281
166	-0.00001	-0.00001	-0.00001	-0.00001	-0.000105	-0.000105	-0.000219
167	-0.00001	-0.00001	-0.00001	-0.00001	-0.000119	-0.000109	-0.000166

	V_AC	V_-CD	V_-BC	V_-BD	V_-AC	1000/T(1/K)
0	0.010392	-0.002780	-0.003911	-0.012516	-0.011353	10.412328
1	-0.000753	-0.001931	-0.002474	-0.000881	-0.000222	10.265886
2	-0.012569	-0.002969	-0.003452	0.010405	0.011511	10.137875
3	0.010410	-0.002975	-0.004141	-0.012592	-0.011357	9.972078
4	-0.000768	-0.002084	-0.002654	-0.000908	-0.000185	9.837678
5	-0.012639	-0.003175	-0.003687	0.010417	0.011607	9.717229
6	0.010424	-0.003183	-0.004388	-0.012669	-0.011357	9.560229
7	-0.000791	-0.002245	-0.002845	-0.000931	-0.000144	9.429070
8	-0.012716	-0.003394	-0.003944	0.010423	0.011705	9.317060

9	0.010437	-0.003396	-0.004642	-0.012747	-0.011355	9.184423
10	-0.000815	-0.002414	-0.003049	-0.000968	-0.000118	9.078941
11	-0.012795	-0.003613	-0.004202	0.010426	0.011792	8.976258
12	0.010437	-0.003618	-0.004910	-0.012831	-0.011357	8.848774
13	-0.000852	-0.002590	-0.003260	-0.001004	-0.000087	8.748524
14	-0.012875	-0.003848	-0.004478	0.010422	0.011878	8.645284
15	0.010429	-0.003871	-0.005206	-0.012923	-0.011355	8.513899
16	-0.000888	-0.002793	-0.003498	-0.001043	-0.000047	8.421762
17	-0.012962	-0.004097	-0.004773	0.010413	0.011969	8.333333
18	0.010427	-0.004118	-0.005504	-0.013012	-0.011343	8.211866
19	-0.000920	-0.002996	-0.003742	-0.001082	-0.000005	8.126778
20	-0.013040	-0.004350	-0.005073	0.010405	0.012067	8.044082
21	0.010422	-0.004361	-0.005798	-0.013093	-0.011329	7.944074
22	-0.000954	-0.003208	-0.003994	-0.001124	0.000039	7.853609
23	-0.013124	-0.004619	-0.005390	0.010390	0.012161	7.773632
24	0.010418	-0.004630	-0.006119	-0.013184	-0.011311	7.680787
25	-0.000989	-0.003426	-0.004256	-0.001167	0.000084	7.608324
26	-0.013202	-0.004879	-0.005698	0.010379	0.012254	7.534376
27	0.010407	-0.004894	-0.006431	-0.013267	-0.011292	7.445462
28	-0.001029	-0.003660	-0.004537	-0.001212	0.000135	7.367297
29	-0.013286	-0.005163	-0.006034	0.010363	0.012355	7.299536
30	0.010397	-0.005185	-0.006774	-0.013359	-0.011269	7.214226
31	-0.001065	-0.003899	-0.004824	-0.001260	0.000186	7.147707
32	-0.013371	-0.005449	-0.006373	0.010348	0.012457	7.082905
33	0.010388	-0.005473	-0.007118	-0.013444	-0.011237	6.999860
34	-0.001107	-0.004167	-0.005136	-0.001304	0.000245	6.930247
35	-0.013463	-0.005775	-0.006753	0.010333	0.012574	6.864125
36	0.010375	-0.005809	-0.007513	-0.013547	-0.011217	6.786563
37	-0.001153	-0.004455	-0.005477	-0.001352	0.000304	6.725854
38	-0.013563	-0.006112	-0.007146	0.010321	0.012689	6.662669
39	0.010358	-0.006148	-0.007913	-0.013641	-0.011190	6.589135
40	-0.001209	-0.004768	-0.005833	-0.001402	0.000363	6.530399
41	-0.013674	-0.006447	-0.007537	0.010306	0.012795	6.474378
42	0.010325	-0.006479	-0.008305	-0.013751	-0.011178	6.403073
43	-0.001277	-0.005054	-0.006178	-0.001458	0.000406	6.345580
44	-0.013787	-0.006764	-0.007910	0.010288	0.012885	6.294455
45	0.010293	-0.006782	-0.008661	-0.013841	-0.011178	6.229171
46	-0.001343	-0.005318	-0.006486	-0.001500	0.000441	6.179133
47	-0.013893	-0.007062	-0.008253	0.010284	0.012979	6.129329
48	0.010274	-0.007092	-0.009029	-0.013935	-0.011161	6.065201
49	-0.001388	-0.005606	-0.006819	-0.001542	0.000503	6.018115
50	-0.013987	-0.007391	-0.008628	0.010281	0.013099	5.971397
51	0.010272	-0.007432	-0.009414	-0.014019	-0.011119	5.910689
52	-0.001428	-0.005933	-0.007193	-0.001590	0.000593	5.862524
53	-0.014085	-0.007768	-0.009066	0.010267	0.013242	5.813953
54	0.010273	-0.007813	-0.009857	-0.014137	-0.011082	5.759539
55	-0.001482	-0.006298	-0.007618	-0.001652	0.000672	5.711675

56	-0.014200	-0.008156	-0.009522	0.010258	0.013384	5.669738
57	0.010265	-0.008204	-0.010318	-0.014255	-0.011054	5.617662
58	-0.001544	-0.006669	-0.008052	-0.001717	0.000747	5.574447
59	-0.014321	-0.008553	-0.009980	0.010252	0.013530	5.534800
60	0.010256	-0.008604	-0.010792	-0.014384	-0.011033	5.485915
61	-0.001612	-0.007044	-0.008492	-0.001781	0.000827	5.443658
62	-0.014460	-0.008973	-0.010477	0.010235	0.013674	5.402631
63	0.010247	-0.009026	-0.011290	-0.014522	-0.011011	5.356473
64	-0.001675	-0.007455	-0.008971	-0.001851	0.000903	5.316180
65	-0.014599	-0.009404	-0.010976	0.010226	0.013824	5.277463
66	0.010233	-0.009461	-0.011796	-0.014654	-0.010994	5.233684
67	-0.001747	-0.007849	-0.009437	-0.001914	0.000978	5.198181
68	-0.014730	-0.009819	-0.011458	0.010227	0.013966	5.163022
69	0.010226	-0.009900	-0.012301	-0.014791	-0.010979	5.119148
70	-0.001817	-0.008277	-0.009931	-0.001985	0.001058	5.084272
71	-0.014868	-0.010271	-0.011970	0.010234	0.014118	5.049485
72	0.010226	-0.010375	-0.012843	-0.014913	-0.010957	5.001500
73	-0.001888	-0.008750	-0.010468	-0.002040	0.001154	4.964011
74	-0.015008	-0.010789	-0.012554	0.010237	0.014275	4.928536
75	0.010219	-0.010890	-0.013423	-0.015050	-0.010949	4.886391
76	-0.001957	-0.009247	-0.011035	-0.002111	0.001239	4.849661
77	-0.015137	-0.011305	-0.013134	0.010243	0.014421	4.814636
78	0.010231	-0.011407	-0.014001	-0.015168	-0.010933	4.775549
79	-0.002020	-0.009728	-0.011582	-0.002170	0.001311	4.744958
80	-0.015250	-0.011764	-0.013659	0.010234	0.014518	4.716981
81	0.010228	-0.011892	-0.014526	-0.015261	-0.010939	4.680552
82	-0.002073	-0.010215	-0.012115	-0.002219	0.001366	4.649000
83	-0.015328	-0.012297	-0.014213	0.010258	0.014613	4.616805
84	0.010240	-0.012442	-0.015089	-0.015307	-0.010929	4.578755
85	-0.002102	-0.010750	-0.012669	-0.002230	0.001428	4.546488
86	-0.015325	-0.012879	-0.014794	0.010328	0.014736	4.514673
87	0.010319	-0.013083	-0.015653	-0.015250	-0.010852	4.479283
88	-0.002053	-0.011366	-0.013241	-0.002197	0.001518	4.450378
89	-0.015257	-0.013457	-0.015314	0.010327	0.014706	4.420866
90	0.010292	-0.013671	-0.016207	-0.015186	-0.010817	4.385003
91	-0.002059	-0.011919	-0.013789	-0.002194	0.001513	4.356349
92	-0.015124	-0.014000	-0.015838	0.010256	0.014548	4.329004
93	0.010179	-0.014223	-0.016687	-0.014976	-0.010711	4.296455
94	-0.002039	-0.012427	-0.014270	-0.002160	0.001481	4.268032
95	-0.014801	-0.014483	-0.016280	0.010045	0.014193	4.241782
96	0.009882	-0.014699	-0.017059	-0.014523	-0.010408	4.209640
97	-0.002001	-0.012849	-0.014640	-0.002111	0.001433	4.183225
98	-0.014151	-0.014837	-0.016577	0.009541	0.013494	4.158004
99	0.009237	-0.014993	-0.017208	-0.013649	-0.009718	4.127115
100	-0.001938	-0.013056	-0.014774	-0.002032	0.001363	4.102564
101	-0.012950	-0.014912	-0.016599	0.008497	0.012220	4.077472
102	0.007954	-0.014929	-0.016944	-0.012080	-0.008367	4.046945

103	-0.001876	-0.012867	-0.014481	-0.001934	0.001284	4.022526
104	-0.010855	-0.014465	-0.016093	0.006599	0.010062	3.996004
105	0.005805	-0.014212	-0.015999	-0.009619	-0.006149	3.966680
106	-0.001772	-0.012057	-0.013545	-0.001803	0.001192	3.943218
107	-0.008047	-0.013282	-0.014838	0.004032	0.007186	3.920031
108	0.003139	-0.012721	-0.014263	-0.006627	-0.003449	3.891808
109	-0.001647	-0.010628	-0.011954	-0.001643	0.001058	3.869220
110	-0.005069	-0.011422	-0.012845	0.001432	0.004229	3.847634
111	0.000695	-0.010663	-0.011952	-0.003828	-0.001068	3.820439
112	-0.001465	-0.008803	-0.009939	-0.001425	0.000877	3.798670
113	-0.002652	-0.009248	-0.010464	-0.000464	0.001901	3.777148
114	-0.000899	-0.008475	-0.009520	-0.001822	0.000447	3.751641
115	-0.001255	-0.006969	-0.007891	-0.001202	0.000679	3.730647
116	-0.001135	-0.007189	-0.008173	-0.001421	0.000484	3.709887
117	-0.001614	-0.006518	-0.007340	-0.000670	0.001105	3.685957
118	-0.001041	-0.005400	-0.006123	-0.000985	0.000482	3.665689
119	-0.000361	-0.005502	-0.006267	-0.001709	-0.000232	3.645643
120	-0.001762	-0.004968	-0.005608	-0.000138	0.001218	3.621876
121	-0.000863	-0.004164	-0.004726	-0.000814	0.000317	3.602305
122	-0.000021	-0.004209	-0.004789	-0.001649	-0.000521	3.582945
123	-0.001635	-0.003800	-0.004293	0.000069	0.001096	3.560620
124	-0.000718	-0.003226	-0.003658	-0.000675	0.000186	3.541076
125	0.000085	-0.003245	-0.003688	-0.001465	-0.000598	3.522367
126	-0.001428	-0.002939	-0.003315	0.000113	0.000886	3.500788
127	-0.000605	-0.002530	-0.002859	-0.000574	0.000085	3.482500
128	0.000093	-0.002534	-0.002867	-0.001247	-0.000590	3.464403
129	-0.001213	-0.002307	-0.002602	0.000086	0.000686	3.442933
130	-0.000521	-0.002004	-0.002260	-0.000494	0.000010	3.425244
131	0.000062	-0.002004	-0.002264	-0.001051	-0.000545	3.407736
132	-0.001023	-0.001830	-0.002059	0.000038	0.000496	3.385813
133	-0.000456	-0.001607	-0.001806	-0.000438	-0.000047	3.368705
134	0.000017	-0.001607	-0.001811	-0.000884	-0.000491	3.352330
135	-0.000854	-0.001473	-0.001659	-0.000006	0.000354	3.331667
136	-0.000404	-0.001311	-0.001474	-0.000394	-0.000088	3.315650
137	-0.000026	-0.001316	-0.001471	-0.000748	-0.000442	3.298697
138	-0.000728	-0.001213	-0.001359	-0.000053	0.000232	3.279226
139	-0.000366	-0.001091	-0.001220	-0.000359	-0.000113	3.263175
140	-0.000058	-0.001091	-0.001216	-0.000643	-0.000400	3.247280
141	-0.000624	-0.001006	-0.001129	-0.000092	0.000134	3.227889
142	-0.000335	-0.000920	-0.001025	-0.000335	-0.000138	3.212335
143	-0.000091	-0.000921	-0.001022	-0.000560	-0.000360	3.196420
144	-0.000542	-0.000852	-0.000954	-0.000123	0.000069	3.177629
145	-0.000313	-0.000786	-0.000869	-0.000314	-0.000154	3.161555
146	-0.000115	-0.000787	-0.000868	-0.000492	-0.000330	3.146633
147	-0.000475	-0.000729	-0.000814	-0.000144	0.000010	3.128422
148	-0.000287	-0.000680	-0.000752	-0.000297	-0.000158	3.113810
149	-0.000126	-0.000684	-0.000750	-0.000437	-0.000294	3.098853

```

150 -0.000419 -0.000633 -0.000709 -0.000168 -0.000032 3.081664
151 -0.000275 -0.000601 -0.000659 -0.000282 -0.000172 3.067485
152 -0.000147 -0.000606 -0.000661 -0.000398 -0.000288 3.055768
153 -0.000388 -0.000570 -0.000638 -0.000183 -0.000069 3.041363
154 -0.000266 -0.000544 -0.000600 -0.000279 -0.000174 3.028926
155 -0.000154 -0.000550 -0.000603 -0.000375 -0.000267 3.017046
156 -0.000355 -0.000517 -0.000583 -0.000202 -0.000087 3.001651
157 -0.000250 -0.000495 -0.000546 -0.000278 -0.000174 2.988643
158 -0.000154 -0.000499 -0.000547 -0.000349 -0.000247 2.975305
159 -0.000324 -0.000468 -0.000530 -0.000211 -0.000110 2.959893
160 -0.000241 -0.000454 -0.000504 -0.000271 -0.000180 2.947244
161 -0.000164 -0.000463 -0.000504 -0.000329 -0.000233 2.934272
162 -0.000300 -0.000433 -0.000489 -0.000221 -0.000124 2.918856
163 -0.000233 -0.000429 -0.000468 -0.000268 -0.000184 2.906132
164 -0.000173 -0.000433 -0.000470 -0.000311 -0.000229 2.893519
165 -0.000286 -0.000399 -0.000455 -0.000224 -0.000137 2.878526
166 -0.000218 -0.000397 -0.000438 -0.000266 -0.000175 2.866151
167 -0.000160 -0.000408 -0.000438 -0.000298 -0.000202 2.853881

```

```

[52]: # The data for positive magnetic field.
run1_BPos = run1[run1.index % 3 == 0]
run1_BPos.reset_index(drop=True)

```

```

[52]:      Temperature(K)  B-Field(Tesla)  I_AB  I_AD  I_AC  I_BD  \
0           96.040         0.5317  0.00001  0.00001  0.00001  0.00001
1          100.280         0.5317  0.00001  0.00001  0.00001  0.00001
2          104.600         0.5315  0.00001  0.00001  0.00001  0.00001
3          108.880         0.5315  0.00001  0.00001  0.00001  0.00001
4          113.010         0.5314  0.00001  0.00001  0.00001  0.00001
5          117.455         0.5313  0.00001  0.00001  0.00001  0.00001
6          121.775         0.5311  0.00001  0.00001  0.00001  0.00001
7          125.880         0.5311  0.00001  0.00001  0.00001  0.00001
8          130.195         0.5310  0.00001  0.00001  0.00001  0.00001
9          134.310         0.5309  0.00001  0.00001  0.00001  0.00001
10         138.615         0.5308  0.00001  0.00001  0.00001  0.00001
11         142.860         0.5307  0.00001  0.00001  0.00001  0.00001
12         147.350         0.5306  0.00001  0.00001  0.00001  0.00001
13         151.765         0.5306  0.00001  0.00001  0.00001  0.00001
14         156.175         0.5305  0.00001  0.00001  0.00001  0.00001
15         160.535         0.5305  0.00001  0.00001  0.00001  0.00001
16         164.875         0.5306  0.00001  0.00001  0.00001  0.00001
17         169.185         0.5305  0.00001  0.00001  0.00001  0.00001
18         173.625         0.5305  0.00001  0.00001  0.00001  0.00001
19         178.010         0.5304  0.00001  0.00001  0.00001  0.00001
20         182.285         0.5303  0.00001  0.00001  0.00001  0.00001
21         186.690         0.5304  0.00001  0.00001  0.00001  0.00001
22         191.070         0.5304  0.00001  0.00001  0.00001  0.00001

```

23	195.345	0.5303	0.00001	0.00001	0.00001	0.00001
24	199.940	0.5303	0.00001	0.00001	0.00001	0.00001
25	204.650	0.5304	0.00001	0.00001	0.00001	0.00001
26	209.400	0.5304	0.00001	0.00001	0.00001	0.00001
27	213.650	0.5303	0.00001	0.00001	0.00001	0.00001
28	218.400	0.5303	0.00001	0.00001	0.00001	0.00001
29	223.250	0.5303	0.00001	0.00001	0.00001	0.00001
30	228.050	0.5303	0.00001	0.00001	0.00001	0.00001
31	232.750	0.5303	0.00001	0.00001	0.00001	0.00001
32	237.550	0.5303	0.00001	0.00001	0.00001	0.00001
33	242.300	0.5303	0.00001	0.00001	0.00001	0.00001
34	247.100	0.5304	0.00001	0.00001	0.00001	0.00001
35	252.100	0.5304	0.00001	0.00001	0.00001	0.00001
36	256.950	0.5303	0.00001	0.00001	0.00001	0.00001
37	261.750	0.5303	0.00001	0.00001	0.00001	0.00001
38	266.550	0.5303	0.00001	0.00001	0.00001	0.00001
39	271.300	0.5303	0.00001	0.00001	0.00001	0.00001
40	276.100	0.5302	0.00001	0.00001	0.00001	0.00001
41	280.850	0.5302	0.00001	0.00001	0.00001	0.00001
42	285.650	0.5303	0.00001	0.00001	0.00001	0.00001
43	290.450	0.5303	0.00001	0.00001	0.00001	0.00001
44	295.350	0.5302	0.00001	0.00001	0.00001	0.00001
45	300.150	0.5302	0.00001	0.00001	0.00001	0.00001
46	304.950	0.5302	0.00001	0.00001	0.00001	0.00001
47	309.800	0.5302	0.00001	0.00001	0.00001	0.00001
48	314.700	0.5303	0.00001	0.00001	0.00001	0.00001
49	319.650	0.5302	0.00001	0.00001	0.00001	0.00001
50	324.500	0.5302	0.00001	0.00001	0.00001	0.00001
51	328.800	0.5302	0.00001	0.00001	0.00001	0.00001
52	333.150	0.5302	0.00001	0.00001	0.00001	0.00001
53	337.850	0.5301	0.00001	0.00001	0.00001	0.00001
54	342.600	0.5302	0.00001	0.00001	0.00001	0.00001
55	347.400	0.5301	0.00001	0.00001	0.00001	0.00001

	I_-AB	I_-AD	I_-AC	I_-BD	V_CD	V_BC	V_BD \
0	-0.00001	-0.00001	-0.00001	-0.00001	-0.002760	0.003342	0.011449
1	-0.00001	-0.00001	-0.00001	-0.00001	0.002909	0.003561	0.011538
2	-0.00001	-0.00001	-0.00001	-0.00001	0.003110	0.003805	0.011631
3	-0.00001	-0.00001	-0.00001	-0.00001	0.003328	0.004069	0.011716
4	-0.00001	-0.00001	-0.00001	-0.00001	0.003536	0.004322	0.011800
5	-0.00001	-0.00001	-0.00001	-0.00001	0.003770	0.004606	0.011881
6	-0.00001	-0.00001	-0.00001	-0.00001	0.004018	0.004905	0.011979
7	-0.00001	-0.00001	-0.00001	-0.00001	0.004255	0.005194	0.012062
8	-0.00001	-0.00001	-0.00001	-0.00001	0.004518	0.005513	0.012151
9	-0.00001	-0.00001	-0.00001	-0.00001	0.004781	0.005834	0.012242
10	-0.00001	-0.00001	-0.00001	-0.00001	0.005061	0.006170	0.012338
11	-0.00001	-0.00001	-0.00001	-0.00001	0.005348	0.006519	0.012440

12	-0.00001	-0.00001	-0.00001	-0.00001	0.005665	0.006909	0.012553
13	-0.00001	-0.00001	-0.00001	-0.00001	0.005994	0.007319	0.012676
14	-0.00001	-0.00001	-0.00001	-0.00001	0.006315	0.007707	0.012785
15	-0.00001	-0.00001	-0.00001	-0.00001	0.006617	0.008078	0.012895
16	-0.00001	-0.00001	-0.00001	-0.00001	0.006910	0.008444	0.013007
17	-0.00001	-0.00001	-0.00001	-0.00001	0.007218	0.008838	0.013135
18	-0.00001	-0.00001	-0.00001	-0.00001	0.007563	0.009269	0.013271
19	-0.00001	-0.00001	-0.00001	-0.00001	0.007950	0.009738	0.013412
20	-0.00001	-0.00001	-0.00001	-0.00001	0.008331	0.010209	0.013549
21	-0.00001	-0.00001	-0.00001	-0.00001	0.008744	0.010710	0.013699
22	-0.00001	-0.00001	-0.00001	-0.00001	0.009165	0.011219	0.013853
23	-0.00001	-0.00001	-0.00001	-0.00001	0.009588	0.011727	0.014001
24	-0.00001	-0.00001	-0.00001	-0.00001	0.010045	0.012276	0.014163
25	-0.00001	-0.00001	-0.00001	-0.00001	0.010532	0.012856	0.014316
26	-0.00001	-0.00001	-0.00001	-0.00001	0.011058	0.013455	0.014460
27	-0.00001	-0.00001	-0.00001	-0.00001	0.011527	0.013969	0.014552
28	-0.00001	-0.00001	-0.00001	-0.00001	0.012063	0.014545	0.014643
29	-0.00001	-0.00001	-0.00001	-0.00001	0.012512	0.015089	0.014745
30	-0.00001	-0.00001	-0.00001	-0.00001	0.013116	0.015662	0.014690
31	-0.00001	-0.00001	-0.00001	-0.00001	0.013682	0.016163	0.014502
32	-0.00001	-0.00001	-0.00001	-0.00001	0.014176	0.016564	0.014076
33	-0.00001	-0.00001	-0.00001	-0.00001	0.014507	0.016749	0.013258
34	-0.00001	-0.00001	-0.00001	-0.00001	0.014488	0.016548	0.011771
35	-0.00001	-0.00001	-0.00001	-0.00001	0.013823	0.015667	0.009376
36	-0.00001	-0.00001	-0.00001	-0.00001	0.012391	0.014013	0.006435
37	-0.00001	-0.00001	-0.00001	-0.00001	0.010358	0.011748	0.003594
38	-0.00001	-0.00001	-0.00001	-0.00001	0.008156	0.009295	0.001502
39	-0.00001	-0.00001	-0.00001	-0.00001	0.006185	0.007076	0.000283
40	-0.00001	-0.00001	-0.00001	-0.00001	0.004611	0.005296	-0.000302
41	-0.00001	-0.00001	-0.00001	-0.00001	0.003425	0.003936	-0.000527
42	-0.00001	-0.00001	-0.00001	-0.00001	0.002532	0.002915	-0.000588
43	-0.00001	-0.00001	-0.00001	-0.00001	0.001881	0.002167	-0.000574
44	-0.00001	-0.00001	-0.00001	-0.00001	0.001388	0.001604	-0.000535
45	-0.00001	-0.00001	-0.00001	-0.00001	0.001030	0.001192	-0.000483
46	-0.00001	-0.00001	-0.00001	-0.00001	0.000761	0.000883	-0.000441
47	-0.00001	-0.00001	-0.00001	-0.00001	0.000547	0.000638	-0.000399
48	-0.00001	-0.00001	-0.00001	-0.00001	0.000383	0.000450	0.000000
49	-0.00001	-0.00001	-0.00001	-0.00001	0.000260	0.000310	-0.000344
50	-0.00001	-0.00001	-0.00001	-0.00001	0.000162	0.000192	-0.000326
51	-0.00001	-0.00001	-0.00001	-0.00001	0.000089	0.000116	-0.000314
52	-0.00001	-0.00001	-0.00001	-0.00001	0.000039	0.000053	-0.000307
53	-0.00001	-0.00001	-0.00001	-0.00001	-0.000007	-0.000005	-0.000295
54	-0.00001	-0.00001	-0.00001	-0.00001	-0.000049	-0.000051	-0.000292
55	-0.00001	-0.00001	-0.00001	-0.00001	-0.000080	-0.000094	-0.000281

	V_AC	V_-CD	V_-BC	V_-BD	V_-AC	1000/T(1/K)
0	0.010392	-0.002780	-0.003911	-0.012516	-0.011353	10.412328

1	0.010410	-0.002975	-0.004141	-0.012592	-0.011357	9.972078
2	0.010424	-0.003183	-0.004388	-0.012669	-0.011357	9.560229
3	0.010437	-0.003396	-0.004642	-0.012747	-0.011355	9.184423
4	0.010437	-0.003618	-0.004910	-0.012831	-0.011357	8.848774
5	0.010429	-0.003871	-0.005206	-0.012923	-0.011355	8.513899
6	0.010427	-0.004118	-0.005504	-0.013012	-0.011343	8.211866
7	0.010422	-0.004361	-0.005798	-0.013093	-0.011329	7.944074
8	0.010418	-0.004630	-0.006119	-0.013184	-0.011311	7.680787
9	0.010407	-0.004894	-0.006431	-0.013267	-0.011292	7.445462
10	0.010397	-0.005185	-0.006774	-0.013359	-0.011269	7.214226
11	0.010388	-0.005473	-0.007118	-0.013444	-0.011237	6.999860
12	0.010375	-0.005809	-0.007513	-0.013547	-0.011217	6.786563
13	0.010358	-0.006148	-0.007913	-0.013641	-0.011190	6.589135
14	0.010325	-0.006479	-0.008305	-0.013751	-0.011178	6.403073
15	0.010293	-0.006782	-0.008661	-0.013841	-0.011178	6.229171
16	0.010274	-0.007092	-0.009029	-0.013935	-0.011161	6.065201
17	0.010272	-0.007432	-0.009414	-0.014019	-0.011119	5.910689
18	0.010273	-0.007813	-0.009857	-0.014137	-0.011082	5.759539
19	0.010265	-0.008204	-0.010318	-0.014255	-0.011054	5.617662
20	0.010256	-0.008604	-0.010792	-0.014384	-0.011033	5.485915
21	0.010247	-0.009026	-0.011290	-0.014522	-0.011011	5.356473
22	0.010233	-0.009461	-0.011796	-0.014654	-0.010994	5.233684
23	0.010226	-0.009900	-0.012301	-0.014791	-0.010979	5.119148
24	0.010226	-0.010375	-0.012843	-0.014913	-0.010957	5.001500
25	0.010219	-0.010890	-0.013423	-0.015050	-0.010949	4.886391
26	0.010231	-0.011407	-0.014001	-0.015168	-0.010933	4.775549
27	0.010228	-0.011892	-0.014526	-0.015261	-0.010939	4.680552
28	0.010240	-0.012442	-0.015089	-0.015307	-0.010929	4.578755
29	0.010319	-0.013083	-0.015653	-0.015250	-0.010852	4.479283
30	0.010292	-0.013671	-0.016207	-0.015186	-0.010817	4.385003
31	0.010179	-0.014223	-0.016687	-0.014976	-0.010711	4.296455
32	0.009882	-0.014699	-0.017059	-0.014523	-0.010408	4.209640
33	0.009237	-0.014993	-0.017208	-0.013649	-0.009718	4.127115
34	0.007954	-0.014929	-0.016944	-0.012080	-0.008367	4.046945
35	0.005805	-0.014212	-0.015999	-0.009619	-0.006149	3.966680
36	0.003139	-0.012721	-0.014263	-0.006627	-0.003449	3.891808
37	0.000695	-0.010663	-0.011952	-0.003828	-0.001068	3.820439
38	-0.000899	-0.008475	-0.009520	-0.001822	0.000447	3.751641
39	-0.001614	-0.006518	-0.007340	-0.000670	0.001105	3.685957
40	-0.001762	-0.004968	-0.005608	-0.000138	0.001218	3.621876
41	-0.001635	-0.003800	-0.004293	0.000069	0.001096	3.560620
42	-0.001428	-0.002939	-0.003315	0.000113	0.000886	3.500788
43	-0.001213	-0.002307	-0.002602	0.000086	0.000686	3.442933
44	-0.001023	-0.001830	-0.002059	0.000038	0.000496	3.385813
45	-0.000854	-0.001473	-0.001659	-0.000006	0.000354	3.331667
46	-0.000728	-0.001213	-0.001359	-0.000053	0.000232	3.279226
47	-0.000624	-0.001006	-0.001129	-0.000092	0.000134	3.227889

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48 -0.000542 -0.000852 -0.000954 -0.000123 0.000069 3.177629
49 -0.000475 -0.000729 -0.000814 -0.000144 0.000010 3.128422
50 -0.000419 -0.000633 -0.000709 -0.000168 -0.000032 3.081664
51 -0.000388 -0.000570 -0.000638 -0.000183 -0.000069 3.041363
52 -0.000355 -0.000517 -0.000583 -0.000202 -0.000087 3.001651
53 -0.000324 -0.000468 -0.000530 -0.000211 -0.000110 2.959893
54 -0.000300 -0.000433 -0.000489 -0.000221 -0.000124 2.918856
55 -0.000286 -0.000399 -0.000455 -0.000224 -0.000137 2.878526

```

```

[53]: # The data for negative magnetic field.
run1_BNeg = run1.loc[(run1['B-Field(Tesla)'] < -0.1)]
run1_BNeg.reset_index(drop=True)

```

```

[53]:      Temperature(K)  B-Field(Tesla)  I_AB  I_AD  I_AC  I_BD  \
0          98.640      -0.5168  0.00001  0.00001  0.00001  0.00001
1         102.910      -0.5165  0.00001  0.00001  0.00001  0.00001
2         107.330      -0.5164  0.00001  0.00001  0.00001  0.00001
3         111.405      -0.5163  0.00001  0.00001  0.00001  0.00001
4         115.670      -0.5161  0.00001  0.00001  0.00001  0.00001
5         120.000      -0.5161  0.00001  0.00001  0.00001  0.00001
6         124.315      -0.5159  0.00001  0.00001  0.00001  0.00001
7         128.640      -0.5158  0.00001  0.00001  0.00001  0.00001
8         132.725      -0.5158  0.00001  0.00001  0.00001  0.00001
9         136.995      -0.5156  0.00001  0.00001  0.00001  0.00001
10        141.185      -0.5155  0.00001  0.00001  0.00001  0.00001
11        145.685      -0.5155  0.00001  0.00001  0.00001  0.00001
12        150.090      -0.5154  0.00001  0.00001  0.00001  0.00001
13        154.455      -0.5153  0.00001  0.00001  0.00001  0.00001
14        158.870      -0.5153  0.00001  0.00001  0.00001  0.00001
15        163.150      -0.5153  0.00001  0.00001  0.00001  0.00001
16        167.465      -0.5152  0.00001  0.00001  0.00001  0.00001
17        172.000      -0.5152  0.00001  0.00001  0.00001  0.00001
18        176.375      -0.5152  0.00001  0.00001  0.00001  0.00001
19        180.675      -0.5151  0.00001  0.00001  0.00001  0.00001
20        185.095      -0.5151  0.00001  0.00001  0.00001  0.00001
21        189.485      -0.5151  0.00001  0.00001  0.00001  0.00001
22        193.685      -0.5150  0.00001  0.00001  0.00001  0.00001
23        198.040      -0.5150  0.00001  0.00001  0.00001  0.00001
24        202.900      -0.5150  0.00001  0.00001  0.00001  0.00001
25        207.700      -0.5150  0.00001  0.00001  0.00001  0.00001
26        212.000      -0.5150  0.00001  0.00001  0.00001  0.00001
27        216.600      -0.5150  0.00001  0.00001  0.00001  0.00001
28        221.500      -0.5150  0.00001  0.00001  0.00001  0.00001
29        226.200      -0.5150  0.00001  0.00001  0.00001  0.00001
30        231.000      -0.5149  0.00001  0.00001  0.00001  0.00001
31        235.750      -0.5149  0.00001  0.00001  0.00001  0.00001
32        240.500      -0.5150  0.00001  0.00001  0.00001  0.00001

```


33	245.250	-0.5149	0.00001	0.00001	0.00001	0.00001
34	250.250	-0.5149	0.00001	0.00001	0.00001	0.00001
35	255.100	-0.5149	0.00001	0.00001	0.00001	0.00001
36	259.900	-0.5149	0.00001	0.00001	0.00001	0.00001
37	264.750	-0.5149	0.00001	0.00001	0.00001	0.00001
38	269.550	-0.5148	0.00001	0.00001	0.00001	0.00001
39	274.300	-0.5148	0.00001	0.00001	0.00001	0.00001
40	279.100	-0.5148	0.00001	0.00001	0.00001	0.00001
41	283.900	-0.5149	0.00001	0.00001	0.00001	0.00001
42	288.650	-0.5148	0.00001	0.00001	0.00001	0.00001
43	293.450	-0.5148	0.00001	0.00001	0.00001	0.00001
44	298.300	-0.5148	0.00001	0.00001	0.00001	0.00001
45	303.150	-0.5148	0.00001	0.00001	0.00001	0.00001
46	307.950	-0.5147	0.00001	0.00001	0.00001	0.00001
47	312.850	-0.5147	0.00001	0.00001	0.00001	0.00001
48	317.800	-0.5147	0.00001	0.00001	0.00001	0.00001
49	322.700	-0.5147	0.00001	0.00001	0.00001	0.00001
50	327.250	-0.5146	0.00001	0.00001	0.00001	0.00001
51	331.450	-0.5147	0.00001	0.00001	0.00001	0.00001
52	336.100	-0.5147	0.00001	0.00001	0.00001	0.00001
53	340.800	-0.5147	0.00001	0.00001	0.00001	0.00001
54	345.600	-0.5147	0.00001	0.00001	0.00001	0.00001
55	350.400	-0.5147	0.00001	0.00001	0.00001	0.00001

	I_-AB	I_-AD	I_-AC	I_-BD	V_CD	V_BC	V_BD \
0	-0.00001	-0.00001	-0.00001	-0.00001	0.002935	0.002987	-0.011368
1	-0.00001	-0.00001	-0.00001	-0.00001	0.003125	0.003210	-0.011376
2	-0.00001	-0.00001	-0.00001	-0.00001	0.003343	0.003468	-0.011369
3	-0.00001	-0.00001	-0.00001	-0.00001	0.003551	0.003713	-0.011375
4	-0.00001	-0.00001	-0.00001	-0.00001	0.003766	0.003971	-0.011378
5	-0.00001	-0.00001	-0.00001	-0.00001	0.004016	0.004256	-0.011377
6	-0.00001	-0.00001	-0.00001	-0.00001	0.004261	0.004553	-0.011369
7	-0.00001	-0.00001	-0.00001	-0.00001	0.004520	0.004860	-0.011359
8	-0.00001	-0.00001	-0.00001	-0.00001	0.004783	0.005165	-0.011343
9	-0.00001	-0.00001	-0.00001	-0.00001	0.005056	0.005493	-0.011329
10	-0.00001	-0.00001	-0.00001	-0.00001	0.005338	0.005825	-0.011308
11	-0.00001	-0.00001	-0.00001	-0.00001	0.005647	0.006201	-0.011281
12	-0.00001	-0.00001	-0.00001	-0.00001	0.005971	0.006594	-0.011253
13	-0.00001	-0.00001	-0.00001	-0.00001	0.006302	0.006995	-0.011228
14	-0.00001	-0.00001	-0.00001	-0.00001	0.006611	0.007362	-0.011207
15	-0.00001	-0.00001	-0.00001	-0.00001	0.006895	0.007710	-0.011181
16	-0.00001	-0.00001	-0.00001	-0.00001	0.007198	0.008089	-0.011147
17	-0.00001	-0.00001	-0.00001	-0.00001	0.007548	0.008518	-0.011113
18	-0.00001	-0.00001	-0.00001	-0.00001	0.007918	0.008969	-0.011085
19	-0.00001	-0.00001	-0.00001	-0.00001	0.008305	0.009433	-0.011058
20	-0.00001	-0.00001	-0.00001	-0.00001	0.008709	0.009925	-0.011040
21	-0.00001	-0.00001	-0.00001	-0.00001	0.009120	0.010417	-0.011019

22	-0.00001	-0.00001	-0.00001	-0.00001	0.009533	0.010912	-0.010994
23	-0.00001	-0.00001	-0.00001	-0.00001	0.009962	0.011422	-0.010973
24	-0.00001	-0.00001	-0.00001	-0.00001	0.010458	0.012009	-0.010958
25	-0.00001	-0.00001	-0.00001	-0.00001	0.010960	0.012598	-0.010938
26	-0.00001	-0.00001	-0.00001	-0.00001	0.011445	0.013140	-0.010941
27	-0.00001	-0.00001	-0.00001	-0.00001	0.011934	0.013685	-0.010936
28	-0.00001	-0.00001	-0.00001	-0.00001	0.012433	0.014237	-0.010904
29	-0.00001	-0.00001	-0.00001	-0.00001	0.012894	0.014772	-0.010833
30	-0.00001	-0.00001	-0.00001	-0.00001	0.013454	0.015319	-0.010764
31	-0.00001	-0.00001	-0.00001	-0.00001	0.013957	0.015792	-0.010557
32	-0.00001	-0.00001	-0.00001	-0.00001	0.014327	0.016110	-0.010081
33	-0.00001	-0.00001	-0.00001	-0.00001	0.014445	0.016175	-0.009097
34	-0.00001	-0.00001	-0.00001	-0.00001	0.014057	0.015724	-0.007262
35	-0.00001	-0.00001	-0.00001	-0.00001	0.012943	0.014543	-0.004719
36	-0.00001	-0.00001	-0.00001	-0.00001	0.011131	0.012600	-0.002084
37	-0.00001	-0.00001	-0.00001	-0.00001	0.008968	0.010226	-0.000107
38	-0.00001	-0.00001	-0.00001	-0.00001	0.006882	0.007902	0.000926
39	-0.00001	-0.00001	-0.00001	-0.00001	0.005157	0.005947	0.001254
40	-0.00001	-0.00001	-0.00001	-0.00001	0.003822	0.004425	0.001209
41	-0.00001	-0.00001	-0.00001	-0.00001	0.002827	0.003289	0.001023
42	-0.00001	-0.00001	-0.00001	-0.00001	0.002094	0.002443	0.000810
43	-0.00001	-0.00001	-0.00001	-0.00001	0.001553	0.001825	0.000615
44	-0.00001	-0.00001	-0.00001	-0.00001	0.001142	0.001349	0.000439
45	-0.00001	-0.00001	-0.00001	-0.00001	0.000840	0.000996	0.000305
46	-0.00001	-0.00001	-0.00001	-0.00001	0.000608	0.000736	0.000193
47	-0.00001	-0.00001	-0.00001	-0.00001	0.000425	0.000525	0.000104
48	-0.00001	-0.00001	-0.00001	-0.00001	0.000289	0.000363	0.000037
49	-0.00001	-0.00001	-0.00001	-0.00001	0.000179	0.000240	-0.000014
50	-0.00001	-0.00001	-0.00001	-0.00001	0.000099	0.000149	-0.000058
51	-0.00001	-0.00001	-0.00001	-0.00001	0.000046	0.000081	-0.000087
52	-0.00001	-0.00001	-0.00001	-0.00001	-0.000004	0.000022	-0.000115
53	-0.00001	-0.00001	-0.00001	-0.00001	-0.000048	-0.000030	-0.000137
54	-0.00001	-0.00001	-0.00001	-0.00001	-0.000091	-0.000076	-0.000156
55	-0.00001	-0.00001	-0.00001	-0.00001	-0.000119	-0.000109	-0.000166

	V_AC	V_-CD	V_-BC	V_-BD	V_-AC	1000/T(1/K)
0	-0.012569	-0.002969	-0.003452	0.010405	0.011511	10.137875
1	-0.012639	-0.003175	-0.003687	0.010417	0.011607	9.717229
2	-0.012716	-0.003394	-0.003944	0.010423	0.011705	9.317060
3	-0.012795	-0.003613	-0.004202	0.010426	0.011792	8.976258
4	-0.012875	-0.003848	-0.004478	0.010422	0.011878	8.645284
5	-0.012962	-0.004097	-0.004773	0.010413	0.011969	8.333333
6	-0.013040	-0.004350	-0.005073	0.010405	0.012067	8.044082
7	-0.013124	-0.004619	-0.005390	0.010390	0.012161	7.773632
8	-0.013202	-0.004879	-0.005698	0.010379	0.012254	7.534376
9	-0.013286	-0.005163	-0.006034	0.010363	0.012355	7.299536
10	-0.013371	-0.005449	-0.006373	0.010348	0.012457	7.082905

11	-0.013463	-0.005775	-0.006753	0.010333	0.012574	6.864125
12	-0.013563	-0.006112	-0.007146	0.010321	0.012689	6.662669
13	-0.013674	-0.006447	-0.007537	0.010306	0.012795	6.474378
14	-0.013787	-0.006764	-0.007910	0.010288	0.012885	6.294455
15	-0.013893	-0.007062	-0.008253	0.010284	0.012979	6.129329
16	-0.013987	-0.007391	-0.008628	0.010281	0.013099	5.971397
17	-0.014085	-0.007768	-0.009066	0.010267	0.013242	5.813953
18	-0.014200	-0.008156	-0.009522	0.010258	0.013384	5.669738
19	-0.014321	-0.008553	-0.009980	0.010252	0.013530	5.534800
20	-0.014460	-0.008973	-0.010477	0.010235	0.013674	5.402631
21	-0.014599	-0.009404	-0.010976	0.010226	0.013824	5.277463
22	-0.014730	-0.009819	-0.011458	0.010227	0.013966	5.163022
23	-0.014868	-0.010271	-0.011970	0.010234	0.014118	5.049485
24	-0.015008	-0.010789	-0.012554	0.010237	0.014275	4.928536
25	-0.015137	-0.011305	-0.013134	0.010243	0.014421	4.814636
26	-0.015250	-0.011764	-0.013659	0.010234	0.014518	4.716981
27	-0.015328	-0.012297	-0.014213	0.010258	0.014613	4.616805
28	-0.015325	-0.012879	-0.014794	0.010328	0.014736	4.514673
29	-0.015257	-0.013457	-0.015314	0.010327	0.014706	4.420866
30	-0.015124	-0.014000	-0.015838	0.010256	0.014548	4.329004
31	-0.014801	-0.014483	-0.016280	0.010045	0.014193	4.241782
32	-0.014151	-0.014837	-0.016577	0.009541	0.013494	4.158004
33	-0.012950	-0.014912	-0.016599	0.008497	0.012220	4.077472
34	-0.010855	-0.014465	-0.016093	0.006599	0.010062	3.996004
35	-0.008047	-0.013282	-0.014838	0.004032	0.007186	3.920031
36	-0.005069	-0.011422	-0.012845	0.001432	0.004229	3.847634
37	-0.002652	-0.009248	-0.010464	-0.000464	0.001901	3.777148
38	-0.001135	-0.007189	-0.008173	-0.001421	0.000484	3.709887
39	-0.000361	-0.005502	-0.006267	-0.001709	-0.000232	3.645643
40	-0.000021	-0.004209	-0.004789	-0.001649	-0.000521	3.582945
41	0.000085	-0.003245	-0.003688	-0.001465	-0.000598	3.522367
42	0.000093	-0.002534	-0.002867	-0.001247	-0.000590	3.464403
43	0.000062	-0.002004	-0.002264	-0.001051	-0.000545	3.407736
44	0.000017	-0.001607	-0.001811	-0.000884	-0.000491	3.352330
45	-0.000026	-0.001316	-0.001471	-0.000748	-0.000442	3.298697
46	-0.000058	-0.001091	-0.001216	-0.000643	-0.000400	3.247280
47	-0.000091	-0.000921	-0.001022	-0.000560	-0.000360	3.196420
48	-0.000115	-0.000787	-0.000868	-0.000492	-0.000330	3.146633
49	-0.000126	-0.000684	-0.000750	-0.000437	-0.000294	3.098853
50	-0.000147	-0.000606	-0.000661	-0.000398	-0.000288	3.055768
51	-0.000154	-0.000550	-0.000603	-0.000375	-0.000267	3.017046
52	-0.000154	-0.000499	-0.000547	-0.000349	-0.000247	2.975305
53	-0.000164	-0.000463	-0.000504	-0.000329	-0.000233	2.934272
54	-0.000173	-0.000433	-0.000470	-0.000311	-0.000229	2.893519
55	-0.000160	-0.000408	-0.000438	-0.000298	-0.000202	2.853881

```
[54]: # The data for when we are turning the magnetic field off.
run1_BOff = run1.loc[(run1['B-Field(Tesla)'] < 0.1) & (run1['B-Field(Tesla)'] >_
↳-0.1)]
run1_BOff.reset_index(drop=True)
```

```
[54]:
```

	Temperature(K)	B-Field(Tesla)	I_AB	I_AD	I_AC	I_BD \
0	97.410	0.011890	0.00001	0.00001	0.00001	0.00001
1	101.650	0.011915	0.00001	0.00001	0.00001	0.00001
2	106.055	0.011880	0.00001	0.00001	0.00001	0.00001
3	110.145	0.011887	0.00001	0.00001	0.00001	0.00001
4	114.305	0.011895	0.00001	0.00001	0.00001	0.00001
5	118.740	0.011895	0.00001	0.00001	0.00001	0.00001
6	123.050	0.011886	0.00001	0.00001	0.00001	0.00001
7	127.330	0.011884	0.00001	0.00001	0.00001	0.00001
8	131.435	0.011859	0.00001	0.00001	0.00001	0.00001
9	135.735	0.011864	0.00001	0.00001	0.00001	0.00001
10	139.905	0.011883	0.00001	0.00001	0.00001	0.00001
11	144.295	0.011865	0.00001	0.00001	0.00001	0.00001
12	148.680	0.011883	0.00001	0.00001	0.00001	0.00001
13	153.130	0.011873	0.00001	0.00001	0.00001	0.00001
14	157.590	0.011867	0.00001	0.00001	0.00001	0.00001
15	161.835	0.011877	0.00001	0.00001	0.00001	0.00001
16	166.165	0.011865	0.00001	0.00001	0.00001	0.00001
17	170.575	0.011869	0.00001	0.00001	0.00001	0.00001
18	175.080	0.011898	0.00001	0.00001	0.00001	0.00001
19	179.390	0.011881	0.00001	0.00001	0.00001	0.00001
20	183.700	0.011883	0.00001	0.00001	0.00001	0.00001
21	188.105	0.011896	0.00001	0.00001	0.00001	0.00001
22	192.375	0.011868	0.00001	0.00001	0.00001	0.00001
23	196.685	0.011888	0.00001	0.00001	0.00001	0.00001
24	201.450	0.011879	0.00001	0.00001	0.00001	0.00001
25	206.200	0.011856	0.00001	0.00001	0.00001	0.00001
26	210.750	0.011897	0.00001	0.00001	0.00001	0.00001
27	215.100	0.011870	0.00001	0.00001	0.00001	0.00001
28	219.950	0.011898	0.00001	0.00001	0.00001	0.00001
29	224.700	0.011885	0.00001	0.00001	0.00001	0.00001
30	229.550	0.011868	0.00001	0.00001	0.00001	0.00001
31	234.300	0.011862	0.00001	0.00001	0.00001	0.00001
32	239.050	0.011886	0.00001	0.00001	0.00001	0.00001
33	243.750	0.011887	0.00001	0.00001	0.00001	0.00001
34	248.600	0.011884	0.00001	0.00001	0.00001	0.00001
35	253.600	0.011882	0.00001	0.00001	0.00001	0.00001
36	258.450	0.011872	0.00001	0.00001	0.00001	0.00001
37	263.250	0.011865	0.00001	0.00001	0.00001	0.00001
38	268.050	0.011881	0.00001	0.00001	0.00001	0.00001
39	272.800	0.011885	0.00001	0.00001	0.00001	0.00001
40	277.600	0.011875	0.00001	0.00001	0.00001	0.00001

41	282.400	0.011866	0.00001	0.00001	0.00001	0.00001
42	287.150	0.011875	0.00001	0.00001	0.00001	0.00001
43	291.950	0.011865	0.00001	0.00001	0.00001	0.00001
44	296.850	0.011864	0.00001	0.00001	0.00001	0.00001
45	301.600	0.011883	0.00001	0.00001	0.00001	0.00001
46	306.450	0.011880	0.00001	0.00001	0.00001	0.00001
47	311.300	0.011875	0.00001	0.00001	0.00001	0.00001
48	316.300	0.011893	0.00001	0.00001	0.00001	0.00001
49	321.150	0.011867	0.00001	0.00001	0.00001	0.00001
50	326.000	0.011873	0.00001	0.00001	0.00001	0.00001
51	330.150	0.011868	0.00001	0.00001	0.00001	0.00001
52	334.600	0.011883	0.00001	0.00001	0.00001	0.00001
53	339.300	0.011881	0.00001	0.00001	0.00001	0.00001
54	344.100	0.011885	0.00001	0.00001	0.00001	0.00001
55	348.900	0.011869	0.00001	0.00001	0.00001	0.00001

	I_-AB	I_-AD	I_-AC	I_-BD	V_CD	V_BC	V_BD \
0	-0.00001	-0.00001	-0.00001	-0.00001	0.001836	0.001967	-0.000075
1	-0.00001	-0.00001	-0.00001	-0.00001	0.001979	0.002138	-0.000045
2	-0.00001	-0.00001	-0.00001	-0.00001	0.002137	0.002326	-0.000010
3	-0.00001	-0.00001	-0.00001	-0.00001	0.002303	0.002520	0.000017
4	-0.00001	-0.00001	-0.00001	-0.00001	0.002477	0.002723	0.000047
5	-0.00001	-0.00001	-0.00001	-0.00001	0.002673	0.002955	0.000080
6	-0.00001	-0.00001	-0.00001	-0.00001	0.002876	0.003195	0.000121
7	-0.00001	-0.00001	-0.00001	-0.00001	0.003080	0.003439	0.000159
8	-0.00001	-0.00001	-0.00001	-0.00001	0.003300	0.003695	0.000196
9	-0.00001	-0.00001	-0.00001	-0.00001	0.003530	0.003976	0.000244
10	-0.00001	-0.00001	-0.00001	-0.00001	0.003766	0.004258	0.000292
11	-0.00001	-0.00001	-0.00001	-0.00001	0.004023	0.004567	0.000350
12	-0.00001	-0.00001	-0.00001	-0.00001	0.004301	0.004905	0.000405
13	-0.00001	-0.00001	-0.00001	-0.00001	0.004601	0.005269	0.000478
14	-0.00001	-0.00001	-0.00001	-0.00001	0.004884	0.005612	0.000535
15	-0.00001	-0.00001	-0.00001	-0.00001	0.005143	0.005930	0.000592
16	-0.00001	-0.00001	-0.00001	-0.00001	0.005417	0.006268	0.000661
17	-0.00001	-0.00001	-0.00001	-0.00001	0.005717	0.006640	0.000736
18	-0.00001	-0.00001	-0.00001	-0.00001	0.006054	0.007056	0.000812
19	-0.00001	-0.00001	-0.00001	-0.00001	0.006410	0.007487	0.000887
20	-0.00001	-0.00001	-0.00001	-0.00001	0.006776	0.007928	0.000960
21	-0.00001	-0.00001	-0.00001	-0.00001	0.007161	0.008400	0.001054
22	-0.00001	-0.00001	-0.00001	-0.00001	0.007561	0.008880	0.001130
23	-0.00001	-0.00001	-0.00001	-0.00001	0.007966	0.009373	0.001214
24	-0.00001	-0.00001	-0.00001	-0.00001	0.008427	0.009918	0.001309
25	-0.00001	-0.00001	-0.00001	-0.00001	0.008905	0.010487	0.001397
26	-0.00001	-0.00001	-0.00001	-0.00001	0.009394	0.011042	0.001469
27	-0.00001	-0.00001	-0.00001	-0.00001	0.009864	0.011575	0.001525
28	-0.00001	-0.00001	-0.00001	-0.00001	0.010365	0.012142	0.001597
29	-0.00001	-0.00001	-0.00001	-0.00001	0.010802	0.012683	0.001694

30	-0.00001	-0.00001	-0.00001	-0.00001	0.011368	0.013255	0.001697
31	-0.00001	-0.00001	-0.00001	-0.00001	0.011895	0.013754	0.001674
32	-0.00001	-0.00001	-0.00001	-0.00001	0.012328	0.014137	0.001622
33	-0.00001	-0.00001	-0.00001	-0.00001	0.012578	0.014319	0.001556
34	-0.00001	-0.00001	-0.00001	-0.00001	0.012451	0.014107	0.001469
35	-0.00001	-0.00001	-0.00001	-0.00001	0.011685	0.013216	0.001351
36	-0.00001	-0.00001	-0.00001	-0.00001	0.010282	0.011672	0.001196
37	-0.00001	-0.00001	-0.00001	-0.00001	0.008474	0.009669	0.000996
38	-0.00001	-0.00001	-0.00001	-0.00001	0.006636	0.007608	0.000771
39	-0.00001	-0.00001	-0.00001	-0.00001	0.005039	0.005807	0.000553
40	-0.00001	-0.00001	-0.00001	-0.00001	0.003777	0.004366	0.000367
41	-0.00001	-0.00001	-0.00001	-0.00001	0.002822	0.003265	0.000224
42	-0.00001	-0.00001	-0.00001	-0.00001	0.002103	0.002443	0.000116
43	-0.00001	-0.00001	-0.00001	-0.00001	0.001563	0.001824	0.000032
44	-0.00001	-0.00001	-0.00001	-0.00001	0.001152	0.001351	-0.000035
45	-0.00001	-0.00001	-0.00001	-0.00001	0.000857	0.001005	-0.000077
46	-0.00001	-0.00001	-0.00001	-0.00001	0.000624	0.000743	-0.000110
47	-0.00001	-0.00001	-0.00001	-0.00001	0.000445	0.000532	-0.000138
48	-0.00001	-0.00001	-0.00001	-0.00001	0.000302	0.000371	-0.000155
49	-0.00001	-0.00001	-0.00001	-0.00001	0.000197	0.000247	-0.000174
50	-0.00001	-0.00001	-0.00001	-0.00001	0.000109	0.000151	-0.000182
51	-0.00001	-0.00001	-0.00001	-0.00001	0.000056	0.000091	-0.000190
52	-0.00001	-0.00001	-0.00001	-0.00001	0.000003	0.000025	-0.000207
53	-0.00001	-0.00001	-0.00001	-0.00001	-0.000038	-0.000027	-0.000212
54	-0.00001	-0.00001	-0.00001	-0.00001	-0.000079	-0.000071	-0.000219
55	-0.00001	-0.00001	-0.00001	-0.00001	-0.000105	-0.000105	-0.000219

	V_AC	V_-CD	V_-BC	V_-BD	V_-AC	1000/T(1/K)
0	-0.000753	-0.001931	-0.002474	-0.000881	-0.000222	10.265886
1	-0.000768	-0.002084	-0.002654	-0.000908	-0.000185	9.837678
2	-0.000791	-0.002245	-0.002845	-0.000931	-0.000144	9.429070
3	-0.000815	-0.002414	-0.003049	-0.000968	-0.000118	9.078941
4	-0.000852	-0.002590	-0.003260	-0.001004	-0.000087	8.748524
5	-0.000888	-0.002793	-0.003498	-0.001043	-0.000047	8.421762
6	-0.000920	-0.002996	-0.003742	-0.001082	-0.000005	8.126778
7	-0.000954	-0.003208	-0.003994	-0.001124	0.000039	7.853609
8	-0.000989	-0.003426	-0.004256	-0.001167	0.000084	7.608324
9	-0.001029	-0.003660	-0.004537	-0.001212	0.000135	7.367297
10	-0.001065	-0.003899	-0.004824	-0.001260	0.000186	7.147707
11	-0.001107	-0.004167	-0.005136	-0.001304	0.000245	6.930247
12	-0.001153	-0.004455	-0.005477	-0.001352	0.000304	6.725854
13	-0.001209	-0.004768	-0.005833	-0.001402	0.000363	6.530399
14	-0.001277	-0.005054	-0.006178	-0.001458	0.000406	6.345580
15	-0.001343	-0.005318	-0.006486	-0.001500	0.000441	6.179133
16	-0.001388	-0.005606	-0.006819	-0.001542	0.000503	6.018115
17	-0.001428	-0.005933	-0.007193	-0.001590	0.000593	5.862524
18	-0.001482	-0.006298	-0.007618	-0.001652	0.000672	5.711675

19	-0.001544	-0.006669	-0.008052	-0.001717	0.000747	5.574447
20	-0.001612	-0.007044	-0.008492	-0.001781	0.000827	5.443658
21	-0.001675	-0.007455	-0.008971	-0.001851	0.000903	5.316180
22	-0.001747	-0.007849	-0.009437	-0.001914	0.000978	5.198181
23	-0.001817	-0.008277	-0.009931	-0.001985	0.001058	5.084272
24	-0.001888	-0.008750	-0.010468	-0.002040	0.001154	4.964011
25	-0.001957	-0.009247	-0.011035	-0.002111	0.001239	4.849661
26	-0.002020	-0.009728	-0.011582	-0.002170	0.001311	4.744958
27	-0.002073	-0.010215	-0.012115	-0.002219	0.001366	4.649000
28	-0.002102	-0.010750	-0.012669	-0.002230	0.001428	4.546488
29	-0.002053	-0.011366	-0.013241	-0.002197	0.001518	4.450378
30	-0.002059	-0.011919	-0.013789	-0.002194	0.001513	4.356349
31	-0.002039	-0.012427	-0.014270	-0.002160	0.001481	4.268032
32	-0.002001	-0.012849	-0.014640	-0.002111	0.001433	4.183225
33	-0.001938	-0.013056	-0.014774	-0.002032	0.001363	4.102564
34	-0.001876	-0.012867	-0.014481	-0.001934	0.001284	4.022526
35	-0.001772	-0.012057	-0.013545	-0.001803	0.001192	3.943218
36	-0.001647	-0.010628	-0.011954	-0.001643	0.001058	3.869220
37	-0.001465	-0.008803	-0.009939	-0.001425	0.000877	3.798670
38	-0.001255	-0.006969	-0.007891	-0.001202	0.000679	3.730647
39	-0.001041	-0.005400	-0.006123	-0.000985	0.000482	3.665689
40	-0.000863	-0.004164	-0.004726	-0.000814	0.000317	3.602305
41	-0.000718	-0.003226	-0.003658	-0.000675	0.000186	3.541076
42	-0.000605	-0.002530	-0.002859	-0.000574	0.000085	3.482500
43	-0.000521	-0.002004	-0.002260	-0.000494	0.000010	3.425244
44	-0.000456	-0.001607	-0.001806	-0.000438	-0.000047	3.368705
45	-0.000404	-0.001311	-0.001474	-0.000394	-0.000088	3.315650
46	-0.000366	-0.001091	-0.001220	-0.000359	-0.000113	3.263175
47	-0.000335	-0.000920	-0.001025	-0.000335	-0.000138	3.212335
48	-0.000313	-0.000786	-0.000869	-0.000314	-0.000154	3.161555
49	-0.000287	-0.000680	-0.000752	-0.000297	-0.000158	3.113810
50	-0.000275	-0.000601	-0.000659	-0.000282	-0.000172	3.067485
51	-0.000266	-0.000544	-0.000600	-0.000279	-0.000174	3.028926
52	-0.000250	-0.000495	-0.000546	-0.000278	-0.000174	2.988643
53	-0.000241	-0.000454	-0.000504	-0.000271	-0.000180	2.947244
54	-0.000233	-0.000429	-0.000468	-0.000268	-0.000184	2.906132
55	-0.000218	-0.000397	-0.000438	-0.000266	-0.000175	2.866151

```
[55]: # Plot resistivity versus temperature for positive magnetic field.
import matplotlib.pyplot as plt
f = lambda x : 1/(np.cosh(np.log(x)/2.403))
I = run1.iloc[0]['I_AB']
# Compute the correct horizontal and vertical voltages by canceling any constant
  ↳offset voltages.
index_length = run1_BPos.shape[0]
V_hori = [(run1_BPos.iloc[x]['V_CD'] - run1_BPos.iloc[x]['V_-CD'])/2 for x in
  ↳range(index_length)]
```

```

V_vert = [(run1_BPos.iloc[x]['V_BC'] - run1_BPos.iloc[x]['V_-BC'])/2 for x in
→range(index_length)]
R_hori = [V_hori[x]/I for x in range(index_length)]
R_vert = [V_vert[x]/I for x in range(index_length)]
R_ratio = [R_hori[x]/R_vert[x] for x in range(index_length)]
rho_BPos = [(np.pi*d)/(np.log(2))*(R_hori[x]+R_vert[x])/2*f(R_ratio[x]) for x in
→range(index_length)]
run1_BPos['Resistivity(Ohm)'] = rho_BPos
# print(run1_BPos.max())
# print(run1_BPos.where(run1_BPos['Resistivity(Ohm)'] ==
→run1_BPos['Resistivity(Ohm)'].max()))
run1_BPos.plot(x='Temperature(K)', y="Resistivity(Ohm)", style = 'o')
run1_BPos

```

C:\Users\Todde\Anaconda3\lib\site-packages\ipykernel_launcher.py:13:

SettingWithCopyWarning:

A value is trying to be set on a copy of a slice from a DataFrame.

Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

del sys.path[0]

```

[55]:      Temperature(K)  B-Field(Tesla)    I_AB    I_AD    I_AC    I_BD  \
0           96.040           0.5317  0.00001  0.00001  0.00001  0.00001
3          100.280           0.5317  0.00001  0.00001  0.00001  0.00001
6          104.600           0.5315  0.00001  0.00001  0.00001  0.00001
9          108.880           0.5315  0.00001  0.00001  0.00001  0.00001
12         113.010           0.5314  0.00001  0.00001  0.00001  0.00001
15         117.455           0.5313  0.00001  0.00001  0.00001  0.00001
18         121.775           0.5311  0.00001  0.00001  0.00001  0.00001
21         125.880           0.5311  0.00001  0.00001  0.00001  0.00001
24         130.195           0.5310  0.00001  0.00001  0.00001  0.00001
27         134.310           0.5309  0.00001  0.00001  0.00001  0.00001
30         138.615           0.5308  0.00001  0.00001  0.00001  0.00001
33         142.860           0.5307  0.00001  0.00001  0.00001  0.00001
36         147.350           0.5306  0.00001  0.00001  0.00001  0.00001
39         151.765           0.5306  0.00001  0.00001  0.00001  0.00001
42         156.175           0.5305  0.00001  0.00001  0.00001  0.00001
45         160.535           0.5305  0.00001  0.00001  0.00001  0.00001
48         164.875           0.5306  0.00001  0.00001  0.00001  0.00001
51         169.185           0.5305  0.00001  0.00001  0.00001  0.00001
54         173.625           0.5305  0.00001  0.00001  0.00001  0.00001
57         178.010           0.5304  0.00001  0.00001  0.00001  0.00001
60         182.285           0.5303  0.00001  0.00001  0.00001  0.00001
63         186.690           0.5304  0.00001  0.00001  0.00001  0.00001
66         191.070           0.5304  0.00001  0.00001  0.00001  0.00001

```


69	195.345	0.5303	0.00001	0.00001	0.00001	0.00001
72	199.940	0.5303	0.00001	0.00001	0.00001	0.00001
75	204.650	0.5304	0.00001	0.00001	0.00001	0.00001
78	209.400	0.5304	0.00001	0.00001	0.00001	0.00001
81	213.650	0.5303	0.00001	0.00001	0.00001	0.00001
84	218.400	0.5303	0.00001	0.00001	0.00001	0.00001
87	223.250	0.5303	0.00001	0.00001	0.00001	0.00001
90	228.050	0.5303	0.00001	0.00001	0.00001	0.00001
93	232.750	0.5303	0.00001	0.00001	0.00001	0.00001
96	237.550	0.5303	0.00001	0.00001	0.00001	0.00001
99	242.300	0.5303	0.00001	0.00001	0.00001	0.00001
102	247.100	0.5304	0.00001	0.00001	0.00001	0.00001
105	252.100	0.5304	0.00001	0.00001	0.00001	0.00001
108	256.950	0.5303	0.00001	0.00001	0.00001	0.00001
111	261.750	0.5303	0.00001	0.00001	0.00001	0.00001
114	266.550	0.5303	0.00001	0.00001	0.00001	0.00001
117	271.300	0.5303	0.00001	0.00001	0.00001	0.00001
120	276.100	0.5302	0.00001	0.00001	0.00001	0.00001
123	280.850	0.5302	0.00001	0.00001	0.00001	0.00001
126	285.650	0.5303	0.00001	0.00001	0.00001	0.00001
129	290.450	0.5303	0.00001	0.00001	0.00001	0.00001
132	295.350	0.5302	0.00001	0.00001	0.00001	0.00001
135	300.150	0.5302	0.00001	0.00001	0.00001	0.00001
138	304.950	0.5302	0.00001	0.00001	0.00001	0.00001
141	309.800	0.5302	0.00001	0.00001	0.00001	0.00001
144	314.700	0.5303	0.00001	0.00001	0.00001	0.00001
147	319.650	0.5302	0.00001	0.00001	0.00001	0.00001
150	324.500	0.5302	0.00001	0.00001	0.00001	0.00001
153	328.800	0.5302	0.00001	0.00001	0.00001	0.00001
156	333.150	0.5302	0.00001	0.00001	0.00001	0.00001
159	337.850	0.5301	0.00001	0.00001	0.00001	0.00001
162	342.600	0.5302	0.00001	0.00001	0.00001	0.00001
165	347.400	0.5301	0.00001	0.00001	0.00001	0.00001

	I_-AB	I_-AD	I_-AC	I_-BD	V_CD	V_BC	V_BD \
0	-0.00001	-0.00001	-0.00001	-0.00001	-0.002760	0.003342	0.011449
3	-0.00001	-0.00001	-0.00001	-0.00001	0.002909	0.003561	0.011538
6	-0.00001	-0.00001	-0.00001	-0.00001	0.003110	0.003805	0.011631
9	-0.00001	-0.00001	-0.00001	-0.00001	0.003328	0.004069	0.011716
12	-0.00001	-0.00001	-0.00001	-0.00001	0.003536	0.004322	0.011800
15	-0.00001	-0.00001	-0.00001	-0.00001	0.003770	0.004606	0.011881
18	-0.00001	-0.00001	-0.00001	-0.00001	0.004018	0.004905	0.011979
21	-0.00001	-0.00001	-0.00001	-0.00001	0.004255	0.005194	0.012062
24	-0.00001	-0.00001	-0.00001	-0.00001	0.004518	0.005513	0.012151
27	-0.00001	-0.00001	-0.00001	-0.00001	0.004781	0.005834	0.012242
30	-0.00001	-0.00001	-0.00001	-0.00001	0.005061	0.006170	0.012338
33	-0.00001	-0.00001	-0.00001	-0.00001	0.005348	0.006519	0.012440

36	-0.00001	-0.00001	-0.00001	-0.00001	0.005665	0.006909	0.012553
39	-0.00001	-0.00001	-0.00001	-0.00001	0.005994	0.007319	0.012676
42	-0.00001	-0.00001	-0.00001	-0.00001	0.006315	0.007707	0.012785
45	-0.00001	-0.00001	-0.00001	-0.00001	0.006617	0.008078	0.012895
48	-0.00001	-0.00001	-0.00001	-0.00001	0.006910	0.008444	0.013007
51	-0.00001	-0.00001	-0.00001	-0.00001	0.007218	0.008838	0.013135
54	-0.00001	-0.00001	-0.00001	-0.00001	0.007563	0.009269	0.013271
57	-0.00001	-0.00001	-0.00001	-0.00001	0.007950	0.009738	0.013412
60	-0.00001	-0.00001	-0.00001	-0.00001	0.008331	0.010209	0.013549
63	-0.00001	-0.00001	-0.00001	-0.00001	0.008744	0.010710	0.013699
66	-0.00001	-0.00001	-0.00001	-0.00001	0.009165	0.011219	0.013853
69	-0.00001	-0.00001	-0.00001	-0.00001	0.009588	0.011727	0.014001
72	-0.00001	-0.00001	-0.00001	-0.00001	0.010045	0.012276	0.014163
75	-0.00001	-0.00001	-0.00001	-0.00001	0.010532	0.012856	0.014316
78	-0.00001	-0.00001	-0.00001	-0.00001	0.011058	0.013455	0.014460
81	-0.00001	-0.00001	-0.00001	-0.00001	0.011527	0.013969	0.014552
84	-0.00001	-0.00001	-0.00001	-0.00001	0.012063	0.014545	0.014643
87	-0.00001	-0.00001	-0.00001	-0.00001	0.012512	0.015089	0.014745
90	-0.00001	-0.00001	-0.00001	-0.00001	0.013116	0.015662	0.014690
93	-0.00001	-0.00001	-0.00001	-0.00001	0.013682	0.016163	0.014502
96	-0.00001	-0.00001	-0.00001	-0.00001	0.014176	0.016564	0.014076
99	-0.00001	-0.00001	-0.00001	-0.00001	0.014507	0.016749	0.013258
102	-0.00001	-0.00001	-0.00001	-0.00001	0.014488	0.016548	0.011771
105	-0.00001	-0.00001	-0.00001	-0.00001	0.013823	0.015667	0.009376
108	-0.00001	-0.00001	-0.00001	-0.00001	0.012391	0.014013	0.006435
111	-0.00001	-0.00001	-0.00001	-0.00001	0.010358	0.011748	0.003594
114	-0.00001	-0.00001	-0.00001	-0.00001	0.008156	0.009295	0.001502
117	-0.00001	-0.00001	-0.00001	-0.00001	0.006185	0.007076	0.000283
120	-0.00001	-0.00001	-0.00001	-0.00001	0.004611	0.005296	-0.000302
123	-0.00001	-0.00001	-0.00001	-0.00001	0.003425	0.003936	-0.000527
126	-0.00001	-0.00001	-0.00001	-0.00001	0.002532	0.002915	-0.000588
129	-0.00001	-0.00001	-0.00001	-0.00001	0.001881	0.002167	-0.000574
132	-0.00001	-0.00001	-0.00001	-0.00001	0.001388	0.001604	-0.000535
135	-0.00001	-0.00001	-0.00001	-0.00001	0.001030	0.001192	-0.000483
138	-0.00001	-0.00001	-0.00001	-0.00001	0.000761	0.000883	-0.000441
141	-0.00001	-0.00001	-0.00001	-0.00001	0.000547	0.000638	-0.000399
144	-0.00001	-0.00001	-0.00001	-0.00001	0.000383	0.000450	0.000000
147	-0.00001	-0.00001	-0.00001	-0.00001	0.000260	0.000310	-0.000344
150	-0.00001	-0.00001	-0.00001	-0.00001	0.000162	0.000192	-0.000326
153	-0.00001	-0.00001	-0.00001	-0.00001	0.000089	0.000116	-0.000314
156	-0.00001	-0.00001	-0.00001	-0.00001	0.000039	0.000053	-0.000307
159	-0.00001	-0.00001	-0.00001	-0.00001	-0.000007	-0.000005	-0.000295
162	-0.00001	-0.00001	-0.00001	-0.00001	-0.000049	-0.000051	-0.000292
165	-0.00001	-0.00001	-0.00001	-0.00001	-0.000080	-0.000094	-0.000281

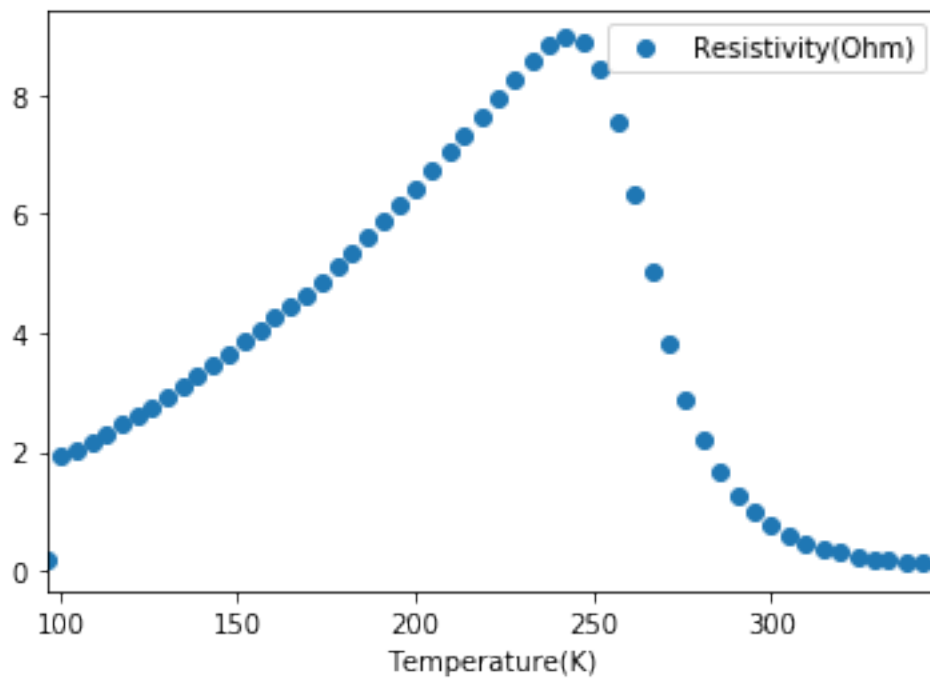
	V_AC	V_-CD	V_-BC	V_-BD	V_-AC	1000/T(1/K)	\
0	0.010392	-0.002780	-0.003911	-0.012516	-0.011353	10.412328	

3	0.010410	-0.002975	-0.004141	-0.012592	-0.011357	9.972078
6	0.010424	-0.003183	-0.004388	-0.012669	-0.011357	9.560229
9	0.010437	-0.003396	-0.004642	-0.012747	-0.011355	9.184423
12	0.010437	-0.003618	-0.004910	-0.012831	-0.011357	8.848774
15	0.010429	-0.003871	-0.005206	-0.012923	-0.011355	8.513899
18	0.010427	-0.004118	-0.005504	-0.013012	-0.011343	8.211866
21	0.010422	-0.004361	-0.005798	-0.013093	-0.011329	7.944074
24	0.010418	-0.004630	-0.006119	-0.013184	-0.011311	7.680787
27	0.010407	-0.004894	-0.006431	-0.013267	-0.011292	7.445462
30	0.010397	-0.005185	-0.006774	-0.013359	-0.011269	7.214226
33	0.010388	-0.005473	-0.007118	-0.013444	-0.011237	6.999860
36	0.010375	-0.005809	-0.007513	-0.013547	-0.011217	6.786563
39	0.010358	-0.006148	-0.007913	-0.013641	-0.011190	6.589135
42	0.010325	-0.006479	-0.008305	-0.013751	-0.011178	6.403073
45	0.010293	-0.006782	-0.008661	-0.013841	-0.011178	6.229171
48	0.010274	-0.007092	-0.009029	-0.013935	-0.011161	6.065201
51	0.010272	-0.007432	-0.009414	-0.014019	-0.011119	5.910689
54	0.010273	-0.007813	-0.009857	-0.014137	-0.011082	5.759539
57	0.010265	-0.008204	-0.010318	-0.014255	-0.011054	5.617662
60	0.010256	-0.008604	-0.010792	-0.014384	-0.011033	5.485915
63	0.010247	-0.009026	-0.011290	-0.014522	-0.011011	5.356473
66	0.010233	-0.009461	-0.011796	-0.014654	-0.010994	5.233684
69	0.010226	-0.009900	-0.012301	-0.014791	-0.010979	5.119148
72	0.010226	-0.010375	-0.012843	-0.014913	-0.010957	5.001500
75	0.010219	-0.010890	-0.013423	-0.015050	-0.010949	4.886391
78	0.010231	-0.011407	-0.014001	-0.015168	-0.010933	4.775549
81	0.010228	-0.011892	-0.014526	-0.015261	-0.010939	4.680552
84	0.010240	-0.012442	-0.015089	-0.015307	-0.010929	4.578755
87	0.010319	-0.013083	-0.015653	-0.015250	-0.010852	4.479283
90	0.010292	-0.013671	-0.016207	-0.015186	-0.010817	4.385003
93	0.010179	-0.014223	-0.016687	-0.014976	-0.010711	4.296455
96	0.009882	-0.014699	-0.017059	-0.014523	-0.010408	4.209640
99	0.009237	-0.014993	-0.017208	-0.013649	-0.009718	4.127115
102	0.007954	-0.014929	-0.016944	-0.012080	-0.008367	4.046945
105	0.005805	-0.014212	-0.015999	-0.009619	-0.006149	3.966680
108	0.003139	-0.012721	-0.014263	-0.006627	-0.003449	3.891808
111	0.000695	-0.010663	-0.011952	-0.003828	-0.001068	3.820439
114	-0.000899	-0.008475	-0.009520	-0.001822	0.000447	3.751641
117	-0.001614	-0.006518	-0.007340	-0.000670	0.001105	3.685957
120	-0.001762	-0.004968	-0.005608	-0.000138	0.001218	3.621876
123	-0.001635	-0.003800	-0.004293	0.000069	0.001096	3.560620
126	-0.001428	-0.002939	-0.003315	0.000113	0.000886	3.500788
129	-0.001213	-0.002307	-0.002602	0.000086	0.000686	3.442933
132	-0.001023	-0.001830	-0.002059	0.000038	0.000496	3.385813
135	-0.000854	-0.001473	-0.001659	-0.000006	0.000354	3.331667
138	-0.000728	-0.001213	-0.001359	-0.000053	0.000232	3.279226
141	-0.000624	-0.001006	-0.001129	-0.000092	0.000134	3.227889

144	-0.000542	-0.000852	-0.000954	-0.000123	0.000069	3.177629
147	-0.000475	-0.000729	-0.000814	-0.000144	0.000010	3.128422
150	-0.000419	-0.000633	-0.000709	-0.000168	-0.000032	3.081664
153	-0.000388	-0.000570	-0.000638	-0.000183	-0.000069	3.041363
156	-0.000355	-0.000517	-0.000583	-0.000202	-0.000087	3.001651
159	-0.000324	-0.000468	-0.000530	-0.000211	-0.000110	2.959893
162	-0.000300	-0.000433	-0.000489	-0.000221	-0.000124	2.918856
165	-0.000286	-0.000399	-0.000455	-0.000224	-0.000137	2.878526

	Resistivity(Ohm)
0	0.176397
3	1.912332
6	2.039554
9	2.173461
12	2.307850
15	2.458682
18	2.612744
21	2.763014
24	2.928681
27	3.092460
30	3.269062
33	3.448149
36	3.651349
39	3.860082
42	4.062279
45	4.250384
48	4.439119
51	4.640672
54	4.866612
57	5.107996
60	5.351549
63	5.610892
66	5.875013
69	6.140037
72	6.425990
75	6.731895
78	7.046131
81	7.328523
84	7.644061
87	7.956262
90	8.286232
93	8.585303
96	8.834503
99	8.972359
102	8.897242
105	8.444850
108	7.552446

111	6.326034
114	5.013907
117	3.835753
120	2.896875
123	2.185770
126	1.654842
129	1.266898
132	0.973426
135	0.757301
138	0.596340
141	0.469668
144	0.373233
147	0.298738
150	0.239928
153	0.199734
156	0.168490
159	0.139325
162	0.116344
165	0.096237



```
[56]: # Plot resistivity versus temperature for negative magnetic field.
import matplotlib.pyplot as plt
f = lambda x : 1/(np.cosh(np.log(x)/2.403))
I = run1.iloc[0]['I_AB']
```

```

# Compute the correct horizontal and vertical voltages by canceling any constant
→offset voltages.
index_length = run1_BNeg.shape[0]
V_hori = [(run1_BNeg.iloc[x]['V_CD'] - run1_BNeg.iloc[x]['V_-CD'])/2 for x in
→range(index_length)]
V_vert = [(run1_BNeg.iloc[x]['V_BC'] - run1_BNeg.iloc[x]['V_-BC'])/2 for x in
→range(index_length)]
R_hori = [V_hori[x]/I for x in range(index_length)]
R_vert = [V_vert[x]/I for x in range(index_length)]
R_ratio = [R_hori[x]/R_vert[x] for x in range(index_length)]
rho_BNeg = [(np.pi*d)/(np.log(2))*(R_hori[x]+R_vert[x])/2*f(R_ratio[x]) for x in
→range(index_length)]
run1_BNeg['Resistivity(Ohm)'] = rho_BNeg
run1_BNeg.plot(x='Temperature(K)', y="Resistivity(Ohm)", style = 'o')
run1_BNeg

```

C:\Users\Todde\Anaconda3\lib\site-packages\ipykernel_launcher.py:13:

SettingWithCopyWarning:

A value is trying to be set on a copy of a slice from a DataFrame.

Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

del sys.path[0]

```

[56]:      Temperature(K)  B-Field(Tesla)    I_AB    I_AD    I_AC    I_BD  \
2          98.640        -0.5168  0.00001  0.00001  0.00001  0.00001
5         102.910        -0.5165  0.00001  0.00001  0.00001  0.00001
8         107.330        -0.5164  0.00001  0.00001  0.00001  0.00001
11        111.405        -0.5163  0.00001  0.00001  0.00001  0.00001
14        115.670        -0.5161  0.00001  0.00001  0.00001  0.00001
17        120.000        -0.5161  0.00001  0.00001  0.00001  0.00001
20        124.315        -0.5159  0.00001  0.00001  0.00001  0.00001
23        128.640        -0.5158  0.00001  0.00001  0.00001  0.00001
26        132.725        -0.5158  0.00001  0.00001  0.00001  0.00001
29        136.995        -0.5156  0.00001  0.00001  0.00001  0.00001
32        141.185        -0.5155  0.00001  0.00001  0.00001  0.00001
35        145.685        -0.5155  0.00001  0.00001  0.00001  0.00001
38        150.090        -0.5154  0.00001  0.00001  0.00001  0.00001
41        154.455        -0.5153  0.00001  0.00001  0.00001  0.00001
44        158.870        -0.5153  0.00001  0.00001  0.00001  0.00001
47        163.150        -0.5153  0.00001  0.00001  0.00001  0.00001
50        167.465        -0.5152  0.00001  0.00001  0.00001  0.00001
53        172.000        -0.5152  0.00001  0.00001  0.00001  0.00001
56        176.375        -0.5152  0.00001  0.00001  0.00001  0.00001
59        180.675        -0.5151  0.00001  0.00001  0.00001  0.00001
62        185.095        -0.5151  0.00001  0.00001  0.00001  0.00001

```

65	189.485	-0.5151	0.00001	0.00001	0.00001	0.00001
68	193.685	-0.5150	0.00001	0.00001	0.00001	0.00001
71	198.040	-0.5150	0.00001	0.00001	0.00001	0.00001
74	202.900	-0.5150	0.00001	0.00001	0.00001	0.00001
77	207.700	-0.5150	0.00001	0.00001	0.00001	0.00001
80	212.000	-0.5150	0.00001	0.00001	0.00001	0.00001
83	216.600	-0.5150	0.00001	0.00001	0.00001	0.00001
86	221.500	-0.5150	0.00001	0.00001	0.00001	0.00001
89	226.200	-0.5150	0.00001	0.00001	0.00001	0.00001
92	231.000	-0.5149	0.00001	0.00001	0.00001	0.00001
95	235.750	-0.5149	0.00001	0.00001	0.00001	0.00001
98	240.500	-0.5150	0.00001	0.00001	0.00001	0.00001
101	245.250	-0.5149	0.00001	0.00001	0.00001	0.00001
104	250.250	-0.5149	0.00001	0.00001	0.00001	0.00001
107	255.100	-0.5149	0.00001	0.00001	0.00001	0.00001
110	259.900	-0.5149	0.00001	0.00001	0.00001	0.00001
113	264.750	-0.5149	0.00001	0.00001	0.00001	0.00001
116	269.550	-0.5148	0.00001	0.00001	0.00001	0.00001
119	274.300	-0.5148	0.00001	0.00001	0.00001	0.00001
122	279.100	-0.5148	0.00001	0.00001	0.00001	0.00001
125	283.900	-0.5149	0.00001	0.00001	0.00001	0.00001
128	288.650	-0.5148	0.00001	0.00001	0.00001	0.00001
131	293.450	-0.5148	0.00001	0.00001	0.00001	0.00001
134	298.300	-0.5148	0.00001	0.00001	0.00001	0.00001
137	303.150	-0.5148	0.00001	0.00001	0.00001	0.00001
140	307.950	-0.5147	0.00001	0.00001	0.00001	0.00001
143	312.850	-0.5147	0.00001	0.00001	0.00001	0.00001
146	317.800	-0.5147	0.00001	0.00001	0.00001	0.00001
149	322.700	-0.5147	0.00001	0.00001	0.00001	0.00001
152	327.250	-0.5146	0.00001	0.00001	0.00001	0.00001
155	331.450	-0.5147	0.00001	0.00001	0.00001	0.00001
158	336.100	-0.5147	0.00001	0.00001	0.00001	0.00001
161	340.800	-0.5147	0.00001	0.00001	0.00001	0.00001
164	345.600	-0.5147	0.00001	0.00001	0.00001	0.00001
167	350.400	-0.5147	0.00001	0.00001	0.00001	0.00001

	I_-AB	I_-AD	I_-AC	I_-BD	V_CD	V_BC	V_BD \
2	-0.00001	-0.00001	-0.00001	-0.00001	0.002935	0.002987	-0.011368
5	-0.00001	-0.00001	-0.00001	-0.00001	0.003125	0.003210	-0.011376
8	-0.00001	-0.00001	-0.00001	-0.00001	0.003343	0.003468	-0.011369
11	-0.00001	-0.00001	-0.00001	-0.00001	0.003551	0.003713	-0.011375
14	-0.00001	-0.00001	-0.00001	-0.00001	0.003766	0.003971	-0.011378
17	-0.00001	-0.00001	-0.00001	-0.00001	0.004016	0.004256	-0.011377
20	-0.00001	-0.00001	-0.00001	-0.00001	0.004261	0.004553	-0.011369
23	-0.00001	-0.00001	-0.00001	-0.00001	0.004520	0.004860	-0.011359
26	-0.00001	-0.00001	-0.00001	-0.00001	0.004783	0.005165	-0.011343
29	-0.00001	-0.00001	-0.00001	-0.00001	0.005056	0.005493	-0.011329

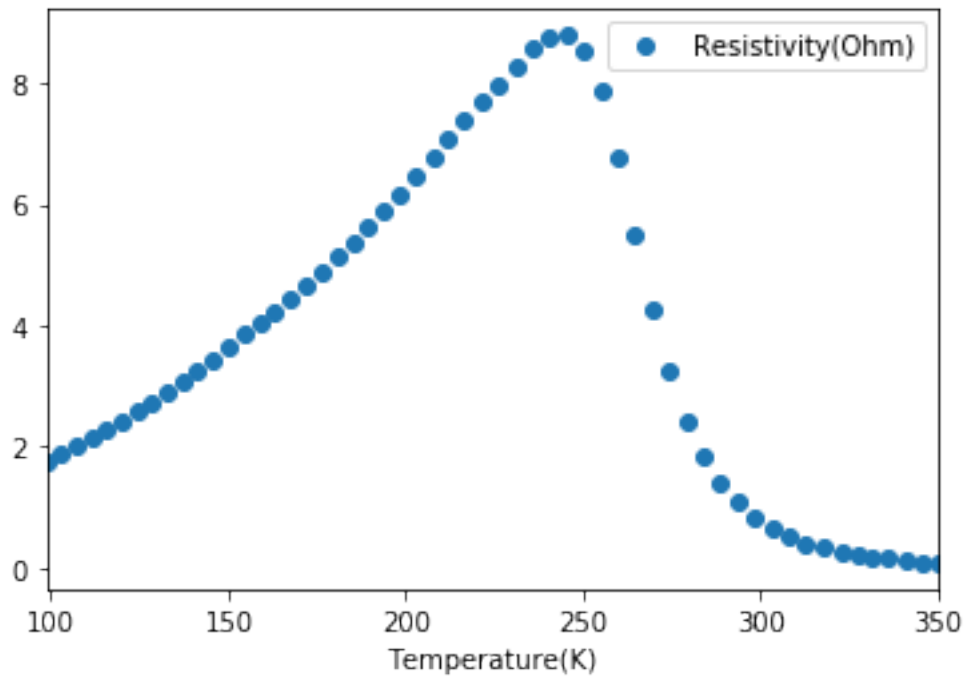
32	-0.00001	-0.00001	-0.00001	-0.00001	0.005338	0.005825	-0.011308
35	-0.00001	-0.00001	-0.00001	-0.00001	0.005647	0.006201	-0.011281
38	-0.00001	-0.00001	-0.00001	-0.00001	0.005971	0.006594	-0.011253
41	-0.00001	-0.00001	-0.00001	-0.00001	0.006302	0.006995	-0.011228
44	-0.00001	-0.00001	-0.00001	-0.00001	0.006611	0.007362	-0.011207
47	-0.00001	-0.00001	-0.00001	-0.00001	0.006895	0.007710	-0.011181
50	-0.00001	-0.00001	-0.00001	-0.00001	0.007198	0.008089	-0.011147
53	-0.00001	-0.00001	-0.00001	-0.00001	0.007548	0.008518	-0.011113
56	-0.00001	-0.00001	-0.00001	-0.00001	0.007918	0.008969	-0.011085
59	-0.00001	-0.00001	-0.00001	-0.00001	0.008305	0.009433	-0.011058
62	-0.00001	-0.00001	-0.00001	-0.00001	0.008709	0.009925	-0.011040
65	-0.00001	-0.00001	-0.00001	-0.00001	0.009120	0.010417	-0.011019
68	-0.00001	-0.00001	-0.00001	-0.00001	0.009533	0.010912	-0.010994
71	-0.00001	-0.00001	-0.00001	-0.00001	0.009962	0.011422	-0.010973
74	-0.00001	-0.00001	-0.00001	-0.00001	0.010458	0.012009	-0.010958
77	-0.00001	-0.00001	-0.00001	-0.00001	0.010960	0.012598	-0.010938
80	-0.00001	-0.00001	-0.00001	-0.00001	0.011445	0.013140	-0.010941
83	-0.00001	-0.00001	-0.00001	-0.00001	0.011934	0.013685	-0.010936
86	-0.00001	-0.00001	-0.00001	-0.00001	0.012433	0.014237	-0.010904
89	-0.00001	-0.00001	-0.00001	-0.00001	0.012894	0.014772	-0.010833
92	-0.00001	-0.00001	-0.00001	-0.00001	0.013454	0.015319	-0.010764
95	-0.00001	-0.00001	-0.00001	-0.00001	0.013957	0.015792	-0.010557
98	-0.00001	-0.00001	-0.00001	-0.00001	0.014327	0.016110	-0.010081
101	-0.00001	-0.00001	-0.00001	-0.00001	0.014445	0.016175	-0.009097
104	-0.00001	-0.00001	-0.00001	-0.00001	0.014057	0.015724	-0.007262
107	-0.00001	-0.00001	-0.00001	-0.00001	0.012943	0.014543	-0.004719
110	-0.00001	-0.00001	-0.00001	-0.00001	0.011131	0.012600	-0.002084
113	-0.00001	-0.00001	-0.00001	-0.00001	0.008968	0.010226	-0.000107
116	-0.00001	-0.00001	-0.00001	-0.00001	0.006882	0.007902	0.000926
119	-0.00001	-0.00001	-0.00001	-0.00001	0.005157	0.005947	0.001254
122	-0.00001	-0.00001	-0.00001	-0.00001	0.003822	0.004425	0.001209
125	-0.00001	-0.00001	-0.00001	-0.00001	0.002827	0.003289	0.001023
128	-0.00001	-0.00001	-0.00001	-0.00001	0.002094	0.002443	0.000810
131	-0.00001	-0.00001	-0.00001	-0.00001	0.001553	0.001825	0.000615
134	-0.00001	-0.00001	-0.00001	-0.00001	0.001142	0.001349	0.000439
137	-0.00001	-0.00001	-0.00001	-0.00001	0.000840	0.000996	0.000305
140	-0.00001	-0.00001	-0.00001	-0.00001	0.000608	0.000736	0.000193
143	-0.00001	-0.00001	-0.00001	-0.00001	0.000425	0.000525	0.000104
146	-0.00001	-0.00001	-0.00001	-0.00001	0.000289	0.000363	0.000037
149	-0.00001	-0.00001	-0.00001	-0.00001	0.000179	0.000240	-0.000014
152	-0.00001	-0.00001	-0.00001	-0.00001	0.000099	0.000149	-0.000058
155	-0.00001	-0.00001	-0.00001	-0.00001	0.000046	0.000081	-0.000087
158	-0.00001	-0.00001	-0.00001	-0.00001	-0.000004	0.000022	-0.000115
161	-0.00001	-0.00001	-0.00001	-0.00001	-0.000048	-0.000030	-0.000137
164	-0.00001	-0.00001	-0.00001	-0.00001	-0.000091	-0.000076	-0.000156
167	-0.00001	-0.00001	-0.00001	-0.00001	-0.000119	-0.000109	-0.000166

	V_AC	V_-CD	V_-BC	V_-BD	V_-AC	1000/T(1/K)	\
2	-0.012569	-0.002969	-0.003452	0.010405	0.011511	10.137875	
5	-0.012639	-0.003175	-0.003687	0.010417	0.011607	9.717229	
8	-0.012716	-0.003394	-0.003944	0.010423	0.011705	9.317060	
11	-0.012795	-0.003613	-0.004202	0.010426	0.011792	8.976258	
14	-0.012875	-0.003848	-0.004478	0.010422	0.011878	8.645284	
17	-0.012962	-0.004097	-0.004773	0.010413	0.011969	8.333333	
20	-0.013040	-0.004350	-0.005073	0.010405	0.012067	8.044082	
23	-0.013124	-0.004619	-0.005390	0.010390	0.012161	7.773632	
26	-0.013202	-0.004879	-0.005698	0.010379	0.012254	7.534376	
29	-0.013286	-0.005163	-0.006034	0.010363	0.012355	7.299536	
32	-0.013371	-0.005449	-0.006373	0.010348	0.012457	7.082905	
35	-0.013463	-0.005775	-0.006753	0.010333	0.012574	6.864125	
38	-0.013563	-0.006112	-0.007146	0.010321	0.012689	6.662669	
41	-0.013674	-0.006447	-0.007537	0.010306	0.012795	6.474378	
44	-0.013787	-0.006764	-0.007910	0.010288	0.012885	6.294455	
47	-0.013893	-0.007062	-0.008253	0.010284	0.012979	6.129329	
50	-0.013987	-0.007391	-0.008628	0.010281	0.013099	5.971397	
53	-0.014085	-0.007768	-0.009066	0.010267	0.013242	5.813953	
56	-0.014200	-0.008156	-0.009522	0.010258	0.013384	5.669738	
59	-0.014321	-0.008553	-0.009980	0.010252	0.013530	5.534800	
62	-0.014460	-0.008973	-0.010477	0.010235	0.013674	5.402631	
65	-0.014599	-0.009404	-0.010976	0.010226	0.013824	5.277463	
68	-0.014730	-0.009819	-0.011458	0.010227	0.013966	5.163022	
71	-0.014868	-0.010271	-0.011970	0.010234	0.014118	5.049485	
74	-0.015008	-0.010789	-0.012554	0.010237	0.014275	4.928536	
77	-0.015137	-0.011305	-0.013134	0.010243	0.014421	4.814636	
80	-0.015250	-0.011764	-0.013659	0.010234	0.014518	4.716981	
83	-0.015328	-0.012297	-0.014213	0.010258	0.014613	4.616805	
86	-0.015325	-0.012879	-0.014794	0.010328	0.014736	4.514673	
89	-0.015257	-0.013457	-0.015314	0.010327	0.014706	4.420866	
92	-0.015124	-0.014000	-0.015838	0.010256	0.014548	4.329004	
95	-0.014801	-0.014483	-0.016280	0.010045	0.014193	4.241782	
98	-0.014151	-0.014837	-0.016577	0.009541	0.013494	4.158004	
101	-0.012950	-0.014912	-0.016599	0.008497	0.012220	4.077472	
104	-0.010855	-0.014465	-0.016093	0.006599	0.010062	3.996004	
107	-0.008047	-0.013282	-0.014838	0.004032	0.007186	3.920031	
110	-0.005069	-0.011422	-0.012845	0.001432	0.004229	3.847634	
113	-0.002652	-0.009248	-0.010464	-0.000464	0.001901	3.777148	
116	-0.001135	-0.007189	-0.008173	-0.001421	0.000484	3.709887	
119	-0.000361	-0.005502	-0.006267	-0.001709	-0.000232	3.645643	
122	-0.000021	-0.004209	-0.004789	-0.001649	-0.000521	3.582945	
125	0.000085	-0.003245	-0.003688	-0.001465	-0.000598	3.522367	
128	0.000093	-0.002534	-0.002867	-0.001247	-0.000590	3.464403	
131	0.000062	-0.002004	-0.002264	-0.001051	-0.000545	3.407736	
134	0.000017	-0.001607	-0.001811	-0.000884	-0.000491	3.352330	
137	-0.000026	-0.001316	-0.001471	-0.000748	-0.000442	3.298697	

140	-0.000058	-0.001091	-0.001216	-0.000643	-0.000400	3.247280
143	-0.000091	-0.000921	-0.001022	-0.000560	-0.000360	3.196420
146	-0.000115	-0.000787	-0.000868	-0.000492	-0.000330	3.146633
149	-0.000126	-0.000684	-0.000750	-0.000437	-0.000294	3.098853
152	-0.000147	-0.000606	-0.000661	-0.000398	-0.000288	3.055768
155	-0.000154	-0.000550	-0.000603	-0.000375	-0.000267	3.017046
158	-0.000154	-0.000499	-0.000547	-0.000349	-0.000247	2.975305
161	-0.000164	-0.000463	-0.000504	-0.000329	-0.000233	2.934272
164	-0.000173	-0.000433	-0.000470	-0.000311	-0.000229	2.893519
167	-0.000160	-0.000408	-0.000438	-0.000298	-0.000202	2.853881

	Resistivity(Ohm)
2	1.747093
5	1.867688
8	2.002428
11	2.133826
14	2.273047
17	2.425455
20	2.580195
23	2.743087
26	2.903530
29	3.076081
32	3.251160
35	3.447948
38	3.652248
41	3.858317
44	4.051255
47	4.231046
50	4.427051
53	4.652122
56	4.887393
59	5.128412
62	5.384403
65	5.643610
68	5.898672
71	6.167733
74	6.476587
77	6.785876
80	7.070459
83	7.370641
86	7.684418
89	7.981412
92	8.289989
95	8.560037
98	8.750472
101	8.790829
104	8.537278

107	7.866995
110	6.789614
113	5.502887
116	4.263120
119	3.234370
122	2.438372
125	1.845176
128	1.405231
131	1.081098
134	0.835510
137	0.653717
140	0.516352
143	0.409071
146	0.326188
149	0.261920
152	0.214174
155	0.180994
158	0.150453
161	0.125525
164	0.104179
167	0.087368



```
[57]: # Plot resistivity versus temperature for B field off.
import matplotlib.pyplot as plt
f = lambda x : 1/(np.cosh(np.log(x)/2.403))
```

```

I = run1.iloc[0]['I_AB']
# Compute the correct horizontal and vertical voltages by canceling any constant
  ↳offset voltages.
index_length = run1_BOff.shape[0]
V_hori = [(run1_BOff.iloc[x]['V_CD'] - run1_BOff.iloc[x]['V_-CD'])/2 for x in
  ↳range(index_length)]
V_vert = [(run1_BOff.iloc[x]['V_BC'] - run1_BOff.iloc[x]['V_-BC'])/2 for x in
  ↳range(index_length)]
R_hori = [V_hori[x]/I for x in range(index_length)]
R_vert = [V_vert[x]/I for x in range(index_length)]
R_ratio = [R_hori[x]/R_vert[x] for x in range(index_length)]
rho_BOff = [(np.pi*d)/(np.log(2))*(R_hori[x]+R_vert[x])/2*f(R_ratio[x]) for x in
  ↳range(index_length)]
run1_BOff['Resistivity(Ohm)'] = rho_BOff
# print(run1_BOff['Resistivity(Ohm)'].max())
# print(run1_BOff.where(run1_BOff['Resistivity(Ohm)'] ==
  ↳run1_BOff['Resistivity(Ohm)'].max()))
run1_BOff.plot(x='Temperature(K)', y="Resistivity(Ohm)", style = 'o')
run1_BOff

```

C:\Users\Todde\Anaconda3\lib\site-packages\ipykernel_launcher.py:13:

SettingWithCopyWarning:

A value is trying to be set on a copy of a slice from a DataFrame.

Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
del sys.path[0]
```

```

[57]:      Temperature(K)  B-Field(Tesla)    I_AB    I_AD    I_AC    I_BD  \
1           97.410         0.011890  0.00001  0.00001  0.00001  0.00001
4          101.650         0.011915  0.00001  0.00001  0.00001  0.00001
7          106.055         0.011880  0.00001  0.00001  0.00001  0.00001
10         110.145         0.011887  0.00001  0.00001  0.00001  0.00001
13         114.305         0.011895  0.00001  0.00001  0.00001  0.00001
16         118.740         0.011895  0.00001  0.00001  0.00001  0.00001
19         123.050         0.011886  0.00001  0.00001  0.00001  0.00001
22         127.330         0.011884  0.00001  0.00001  0.00001  0.00001
25         131.435         0.011859  0.00001  0.00001  0.00001  0.00001
28         135.735         0.011864  0.00001  0.00001  0.00001  0.00001
31         139.905         0.011883  0.00001  0.00001  0.00001  0.00001
34         144.295         0.011865  0.00001  0.00001  0.00001  0.00001
37         148.680         0.011883  0.00001  0.00001  0.00001  0.00001
40         153.130         0.011873  0.00001  0.00001  0.00001  0.00001
43         157.590         0.011867  0.00001  0.00001  0.00001  0.00001
46         161.835         0.011877  0.00001  0.00001  0.00001  0.00001
49         166.165         0.011865  0.00001  0.00001  0.00001  0.00001

```

52	170.575	0.011869	0.00001	0.00001	0.00001	0.00001
55	175.080	0.011898	0.00001	0.00001	0.00001	0.00001
58	179.390	0.011881	0.00001	0.00001	0.00001	0.00001
61	183.700	0.011883	0.00001	0.00001	0.00001	0.00001
64	188.105	0.011896	0.00001	0.00001	0.00001	0.00001
67	192.375	0.011868	0.00001	0.00001	0.00001	0.00001
70	196.685	0.011888	0.00001	0.00001	0.00001	0.00001
73	201.450	0.011879	0.00001	0.00001	0.00001	0.00001
76	206.200	0.011856	0.00001	0.00001	0.00001	0.00001
79	210.750	0.011897	0.00001	0.00001	0.00001	0.00001
82	215.100	0.011870	0.00001	0.00001	0.00001	0.00001
85	219.950	0.011898	0.00001	0.00001	0.00001	0.00001
88	224.700	0.011885	0.00001	0.00001	0.00001	0.00001
91	229.550	0.011868	0.00001	0.00001	0.00001	0.00001
94	234.300	0.011862	0.00001	0.00001	0.00001	0.00001
97	239.050	0.011886	0.00001	0.00001	0.00001	0.00001
100	243.750	0.011887	0.00001	0.00001	0.00001	0.00001
103	248.600	0.011884	0.00001	0.00001	0.00001	0.00001
106	253.600	0.011882	0.00001	0.00001	0.00001	0.00001
109	258.450	0.011872	0.00001	0.00001	0.00001	0.00001
112	263.250	0.011865	0.00001	0.00001	0.00001	0.00001
115	268.050	0.011881	0.00001	0.00001	0.00001	0.00001
118	272.800	0.011885	0.00001	0.00001	0.00001	0.00001
121	277.600	0.011875	0.00001	0.00001	0.00001	0.00001
124	282.400	0.011866	0.00001	0.00001	0.00001	0.00001
127	287.150	0.011875	0.00001	0.00001	0.00001	0.00001
130	291.950	0.011865	0.00001	0.00001	0.00001	0.00001
133	296.850	0.011864	0.00001	0.00001	0.00001	0.00001
136	301.600	0.011883	0.00001	0.00001	0.00001	0.00001
139	306.450	0.011880	0.00001	0.00001	0.00001	0.00001
142	311.300	0.011875	0.00001	0.00001	0.00001	0.00001
145	316.300	0.011893	0.00001	0.00001	0.00001	0.00001
148	321.150	0.011867	0.00001	0.00001	0.00001	0.00001
151	326.000	0.011873	0.00001	0.00001	0.00001	0.00001
154	330.150	0.011868	0.00001	0.00001	0.00001	0.00001
157	334.600	0.011883	0.00001	0.00001	0.00001	0.00001
160	339.300	0.011881	0.00001	0.00001	0.00001	0.00001
163	344.100	0.011885	0.00001	0.00001	0.00001	0.00001
166	348.900	0.011869	0.00001	0.00001	0.00001	0.00001

	I_-AB	I_-AD	I_-AC	I_-BD	V_CD	V_BC	V_BD \
1	-0.00001	-0.00001	-0.00001	-0.00001	0.001836	0.001967	-0.000075
4	-0.00001	-0.00001	-0.00001	-0.00001	0.001979	0.002138	-0.000045
7	-0.00001	-0.00001	-0.00001	-0.00001	0.002137	0.002326	-0.000010
10	-0.00001	-0.00001	-0.00001	-0.00001	0.002303	0.002520	0.000017
13	-0.00001	-0.00001	-0.00001	-0.00001	0.002477	0.002723	0.000047
16	-0.00001	-0.00001	-0.00001	-0.00001	0.002673	0.002955	0.000080

19	-0.00001	-0.00001	-0.00001	-0.00001	0.002876	0.003195	0.000121
22	-0.00001	-0.00001	-0.00001	-0.00001	0.003080	0.003439	0.000159
25	-0.00001	-0.00001	-0.00001	-0.00001	0.003300	0.003695	0.000196
28	-0.00001	-0.00001	-0.00001	-0.00001	0.003530	0.003976	0.000244
31	-0.00001	-0.00001	-0.00001	-0.00001	0.003766	0.004258	0.000292
34	-0.00001	-0.00001	-0.00001	-0.00001	0.004023	0.004567	0.000350
37	-0.00001	-0.00001	-0.00001	-0.00001	0.004301	0.004905	0.000405
40	-0.00001	-0.00001	-0.00001	-0.00001	0.004601	0.005269	0.000478
43	-0.00001	-0.00001	-0.00001	-0.00001	0.004884	0.005612	0.000535
46	-0.00001	-0.00001	-0.00001	-0.00001	0.005143	0.005930	0.000592
49	-0.00001	-0.00001	-0.00001	-0.00001	0.005417	0.006268	0.000661
52	-0.00001	-0.00001	-0.00001	-0.00001	0.005717	0.006640	0.000736
55	-0.00001	-0.00001	-0.00001	-0.00001	0.006054	0.007056	0.000812
58	-0.00001	-0.00001	-0.00001	-0.00001	0.006410	0.007487	0.000887
61	-0.00001	-0.00001	-0.00001	-0.00001	0.006776	0.007928	0.000960
64	-0.00001	-0.00001	-0.00001	-0.00001	0.007161	0.008400	0.001054
67	-0.00001	-0.00001	-0.00001	-0.00001	0.007561	0.008880	0.001130
70	-0.00001	-0.00001	-0.00001	-0.00001	0.007966	0.009373	0.001214
73	-0.00001	-0.00001	-0.00001	-0.00001	0.008427	0.009918	0.001309
76	-0.00001	-0.00001	-0.00001	-0.00001	0.008905	0.010487	0.001397
79	-0.00001	-0.00001	-0.00001	-0.00001	0.009394	0.011042	0.001469
82	-0.00001	-0.00001	-0.00001	-0.00001	0.009864	0.011575	0.001525
85	-0.00001	-0.00001	-0.00001	-0.00001	0.010365	0.012142	0.001597
88	-0.00001	-0.00001	-0.00001	-0.00001	0.010802	0.012683	0.001694
91	-0.00001	-0.00001	-0.00001	-0.00001	0.011368	0.013255	0.001697
94	-0.00001	-0.00001	-0.00001	-0.00001	0.011895	0.013754	0.001674
97	-0.00001	-0.00001	-0.00001	-0.00001	0.012328	0.014137	0.001622
100	-0.00001	-0.00001	-0.00001	-0.00001	0.012578	0.014319	0.001556
103	-0.00001	-0.00001	-0.00001	-0.00001	0.012451	0.014107	0.001469
106	-0.00001	-0.00001	-0.00001	-0.00001	0.011685	0.013216	0.001351
109	-0.00001	-0.00001	-0.00001	-0.00001	0.010282	0.011672	0.001196
112	-0.00001	-0.00001	-0.00001	-0.00001	0.008474	0.009669	0.000996
115	-0.00001	-0.00001	-0.00001	-0.00001	0.006636	0.007608	0.000771
118	-0.00001	-0.00001	-0.00001	-0.00001	0.005039	0.005807	0.000553
121	-0.00001	-0.00001	-0.00001	-0.00001	0.003777	0.004366	0.000367
124	-0.00001	-0.00001	-0.00001	-0.00001	0.002822	0.003265	0.000224
127	-0.00001	-0.00001	-0.00001	-0.00001	0.002103	0.002443	0.000116
130	-0.00001	-0.00001	-0.00001	-0.00001	0.001563	0.001824	0.000032
133	-0.00001	-0.00001	-0.00001	-0.00001	0.001152	0.001351	-0.000035
136	-0.00001	-0.00001	-0.00001	-0.00001	0.000857	0.001005	-0.000077
139	-0.00001	-0.00001	-0.00001	-0.00001	0.000624	0.000743	-0.000110
142	-0.00001	-0.00001	-0.00001	-0.00001	0.000445	0.000532	-0.000138
145	-0.00001	-0.00001	-0.00001	-0.00001	0.000302	0.000371	-0.000155
148	-0.00001	-0.00001	-0.00001	-0.00001	0.000197	0.000247	-0.000174
151	-0.00001	-0.00001	-0.00001	-0.00001	0.000109	0.000151	-0.000182
154	-0.00001	-0.00001	-0.00001	-0.00001	0.000056	0.000091	-0.000190
157	-0.00001	-0.00001	-0.00001	-0.00001	0.000003	0.000025	-0.000207

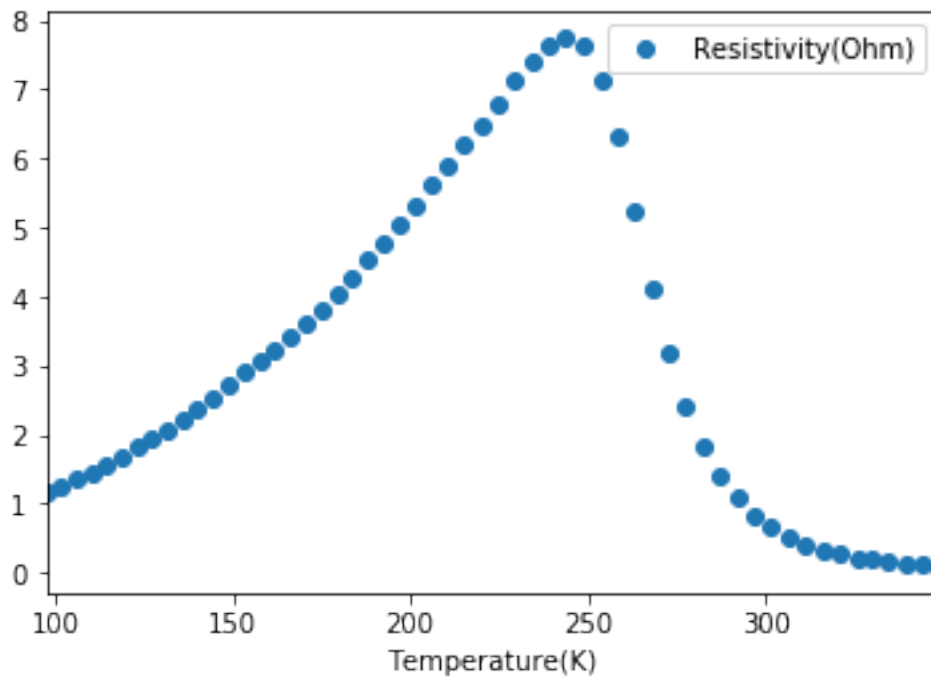
160 -0.00001 -0.00001 -0.00001 -0.00001 -0.000038 -0.000027 -0.000212
163 -0.00001 -0.00001 -0.00001 -0.00001 -0.000079 -0.000071 -0.000219
166 -0.00001 -0.00001 -0.00001 -0.00001 -0.000105 -0.000105 -0.000219

	V_AC	V_-CD	V_-BC	V_-BD	V_-AC	1000/T(1/K)	\
1	-0.000753	-0.001931	-0.002474	-0.000881	-0.000222	10.265886	
4	-0.000768	-0.002084	-0.002654	-0.000908	-0.000185	9.837678	
7	-0.000791	-0.002245	-0.002845	-0.000931	-0.000144	9.429070	
10	-0.000815	-0.002414	-0.003049	-0.000968	-0.000118	9.078941	
13	-0.000852	-0.002590	-0.003260	-0.001004	-0.000087	8.748524	
16	-0.000888	-0.002793	-0.003498	-0.001043	-0.000047	8.421762	
19	-0.000920	-0.002996	-0.003742	-0.001082	-0.000005	8.126778	
22	-0.000954	-0.003208	-0.003994	-0.001124	0.000039	7.853609	
25	-0.000989	-0.003426	-0.004256	-0.001167	0.000084	7.608324	
28	-0.001029	-0.003660	-0.004537	-0.001212	0.000135	7.367297	
31	-0.001065	-0.003899	-0.004824	-0.001260	0.000186	7.147707	
34	-0.001107	-0.004167	-0.005136	-0.001304	0.000245	6.930247	
37	-0.001153	-0.004455	-0.005477	-0.001352	0.000304	6.725854	
40	-0.001209	-0.004768	-0.005833	-0.001402	0.000363	6.530399	
43	-0.001277	-0.005054	-0.006178	-0.001458	0.000406	6.345580	
46	-0.001343	-0.005318	-0.006486	-0.001500	0.000441	6.179133	
49	-0.001388	-0.005606	-0.006819	-0.001542	0.000503	6.018115	
52	-0.001428	-0.005933	-0.007193	-0.001590	0.000593	5.862524	
55	-0.001482	-0.006298	-0.007618	-0.001652	0.000672	5.711675	
58	-0.001544	-0.006669	-0.008052	-0.001717	0.000747	5.574447	
61	-0.001612	-0.007044	-0.008492	-0.001781	0.000827	5.443658	
64	-0.001675	-0.007455	-0.008971	-0.001851	0.000903	5.316180	
67	-0.001747	-0.007849	-0.009437	-0.001914	0.000978	5.198181	
70	-0.001817	-0.008277	-0.009931	-0.001985	0.001058	5.084272	
73	-0.001888	-0.008750	-0.010468	-0.002040	0.001154	4.964011	
76	-0.001957	-0.009247	-0.011035	-0.002111	0.001239	4.849661	
79	-0.002020	-0.009728	-0.011582	-0.002170	0.001311	4.744958	
82	-0.002073	-0.010215	-0.012115	-0.002219	0.001366	4.649000	
85	-0.002102	-0.010750	-0.012669	-0.002230	0.001428	4.546488	
88	-0.002053	-0.011366	-0.013241	-0.002197	0.001518	4.450378	
91	-0.002059	-0.011919	-0.013789	-0.002194	0.001513	4.356349	
94	-0.002039	-0.012427	-0.014270	-0.002160	0.001481	4.268032	
97	-0.002001	-0.012849	-0.014640	-0.002111	0.001433	4.183225	
100	-0.001938	-0.013056	-0.014774	-0.002032	0.001363	4.102564	
103	-0.001876	-0.012867	-0.014481	-0.001934	0.001284	4.022526	
106	-0.001772	-0.012057	-0.013545	-0.001803	0.001192	3.943218	
109	-0.001647	-0.010628	-0.011954	-0.001643	0.001058	3.869220	
112	-0.001465	-0.008803	-0.009939	-0.001425	0.000877	3.798670	
115	-0.001255	-0.006969	-0.007891	-0.001202	0.000679	3.730647	
118	-0.001041	-0.005400	-0.006123	-0.000985	0.000482	3.665689	
121	-0.000863	-0.004164	-0.004726	-0.000814	0.000317	3.602305	
124	-0.000718	-0.003226	-0.003658	-0.000675	0.000186	3.541076	

127	-0.000605	-0.002530	-0.002859	-0.000574	0.000085	3.482500
130	-0.000521	-0.002004	-0.002260	-0.000494	0.000010	3.425244
133	-0.000456	-0.001607	-0.001806	-0.000438	-0.000047	3.368705
136	-0.000404	-0.001311	-0.001474	-0.000394	-0.000088	3.315650
139	-0.000366	-0.001091	-0.001220	-0.000359	-0.000113	3.263175
142	-0.000335	-0.000920	-0.001025	-0.000335	-0.000138	3.212335
145	-0.000313	-0.000786	-0.000869	-0.000314	-0.000154	3.161555
148	-0.000287	-0.000680	-0.000752	-0.000297	-0.000158	3.113810
151	-0.000275	-0.000601	-0.000659	-0.000282	-0.000172	3.067485
154	-0.000266	-0.000544	-0.000600	-0.000279	-0.000174	3.028926
157	-0.000250	-0.000495	-0.000546	-0.000278	-0.000174	2.988643
160	-0.000241	-0.000454	-0.000504	-0.000271	-0.000180	2.947244
163	-0.000233	-0.000429	-0.000468	-0.000268	-0.000184	2.906132
166	-0.000218	-0.000397	-0.000438	-0.000266	-0.000175	2.866151

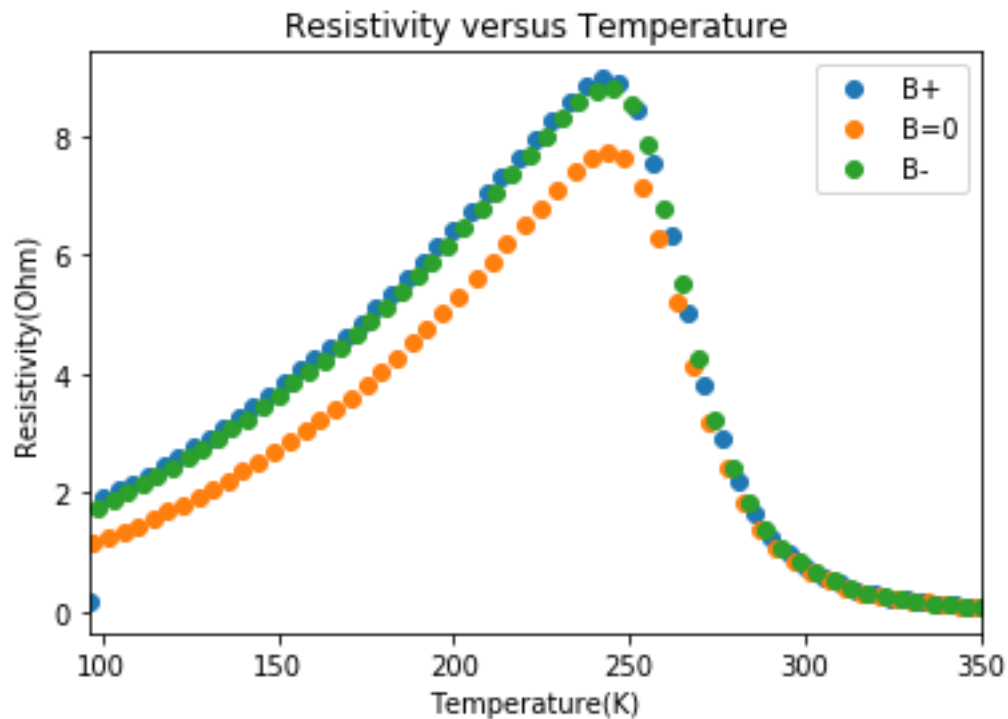
	Resistivity(Ohm)
1	1.159757
4	1.251264
7	1.349901
10	1.453425
13	1.561358
16	1.684001
19	1.809763
22	1.938802
25	2.073835
28	2.218564
31	2.366058
34	2.528111
37	2.703919
40	2.892364
43	3.069794
46	3.231874
49	3.406181
52	3.599990
55	3.818024
58	4.042954
61	4.272098
64	4.518792
67	4.764608
70	5.021688
73	5.306763
76	5.605291
79	5.898273
82	6.184592
85	6.490186
88	6.797205
91	7.114739

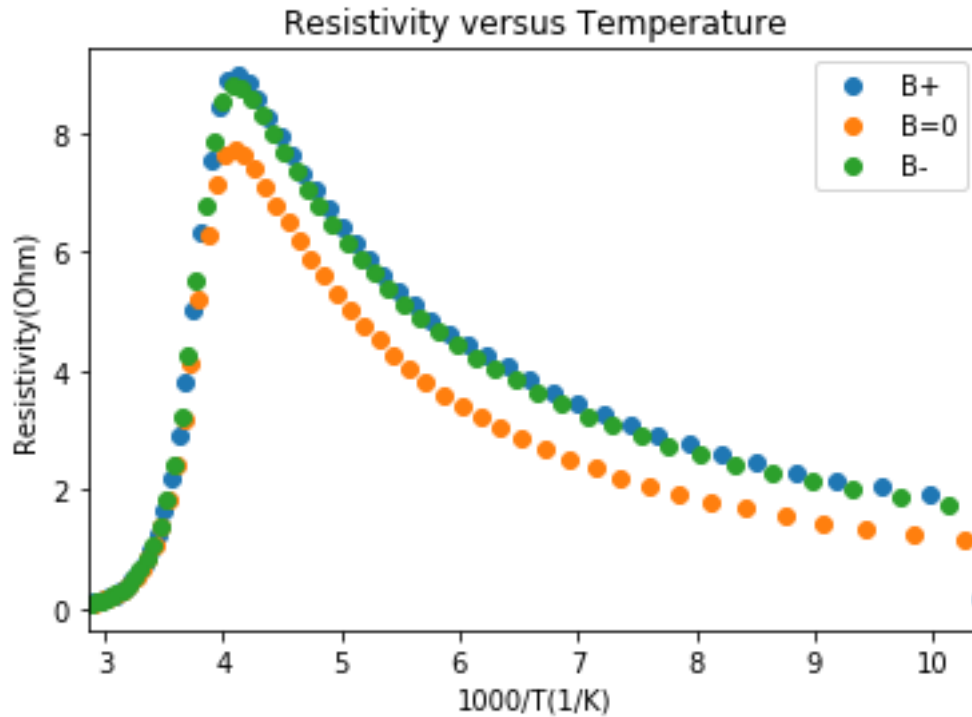
94	7.401214
97	7.630112
100	7.740631
103	7.625216
106	7.144050
109	6.299764
112	5.216944
115	4.116210
118	3.163431
121	2.408673
124	1.834366
127	1.404986
130	1.081904
133	0.836600
136	0.657332
139	0.520087
142	0.413232
145	0.329187
148	0.265262
151	0.215122
154	0.182470
157	0.151099
160	0.126198
163	0.105694
166	0.088432



```
[58]: # The resistivity plots with respect to temperature.
fig, ax = plt.subplots(facecolor='white')
run1_BPos.plot(x= 'Temperature(K)', y = 'Resistivity(Ohm)', ax = ax, style = 'o')
run1_BOff.plot(x='Temperature(K)', y = 'Resistivity(Ohm)', ax = ax, style = 'o')
run1_BNeg.plot(x='Temperature(K)', y = 'Resistivity(Ohm)', ax = ax, style = 'o')
ax.set_ylabel("Resistivity(Ohm)")
ax.set_title("Resistivity versus Temperature")
ax.legend(['B+', 'B=0', 'B-'])
fig, ax = plt.subplots(facecolor='white')
ax = run1_BPos.plot(x= '1000/T(1/K)', y = 'Resistivity(Ohm)', ax = ax, style = 'o')
run1_BOff.plot(x='1000/T(1/K)', y = 'Resistivity(Ohm)', ax = ax, style = 'o')
run1_BNeg.plot(x='1000/T(1/K)', y = 'Resistivity(Ohm)', ax = ax, style = 'o')
ax.set_ylabel("Resistivity(Ohm)")
ax.set_title("Resistivity versus Temperature")
ax.legend(['B+', 'B=0', 'B-'])
```

[58]: <matplotlib.legend.Legend at 0x180d5618b88>



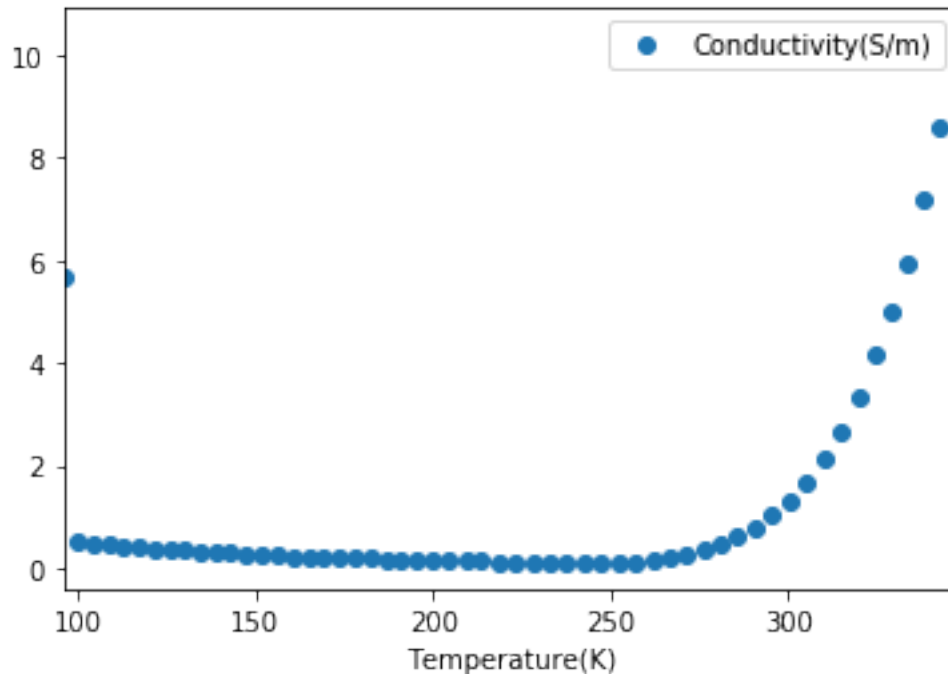


```
[59]: # Plot of conductivity for positive magnetic field.
import matplotlib.pyplot as plt
conductivity_BPos = [1/rho_BPos[x] for x in range(index_length)]
run1_BPos['Conductivity(S/m)'] = conductivity_BPos
run1_BPos.plot(x='Temperature(K)', y="Conductivity(S/m)", style = 'o')
# run1_BPos
```

C:\Users\Todde\Anaconda3\lib\site-packages\ipykernel_launcher.py:4:
 SettingWithCopyWarning:
 A value is trying to be set on a copy of a slice from a DataFrame.
 Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
 after removing the cwd from sys.path.

```
[59]: <matplotlib.axes._subplots.AxesSubplot at 0x180d53d8888>
```

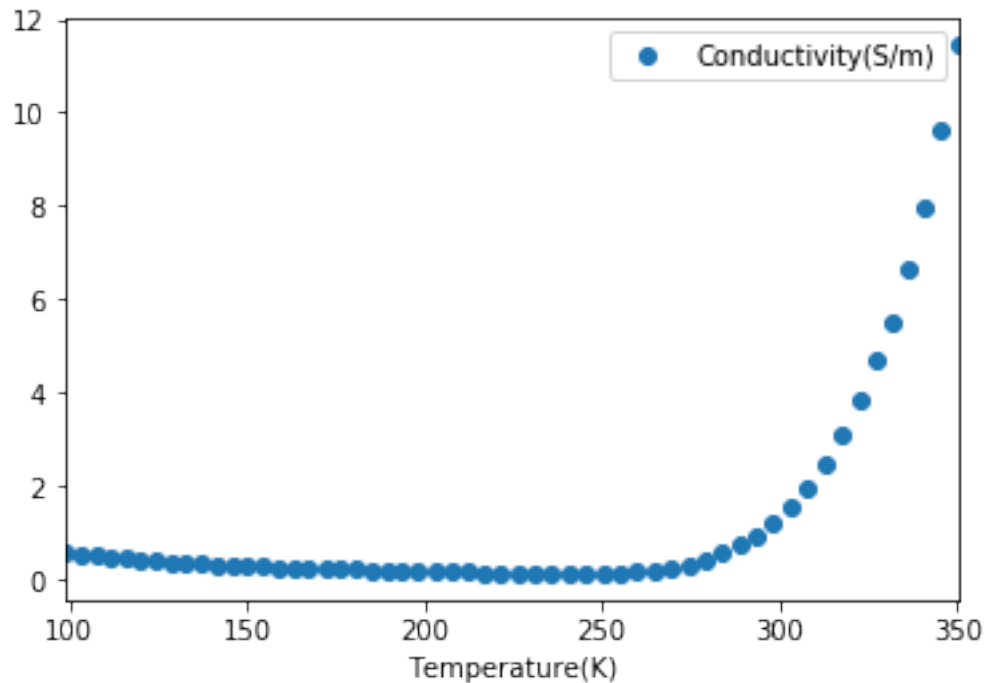


```
[60]: # Plot of conductivity for negative magnetic field.
import matplotlib.pyplot as plt
conductivity_BNeg = [1/rho_BNeg[x] for x in range(index_length)]
run1_BNeg['Conductivity(S/m)'] = conductivity_BNeg
run1_BNeg.plot(x='Temperature(K)', y="Conductivity(S/m)", style = 'o')
# run1_BPos
```

C:\Users\Todde\Anaconda3\lib\site-packages\ipykernel_launcher.py:4:
 SettingWithCopyWarning:
 A value is trying to be set on a copy of a slice from a DataFrame.
 Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
 after removing the cwd from sys.path.

```
[60]: <matplotlib.axes._subplots.AxesSubplot at 0x180d56d6588>
```

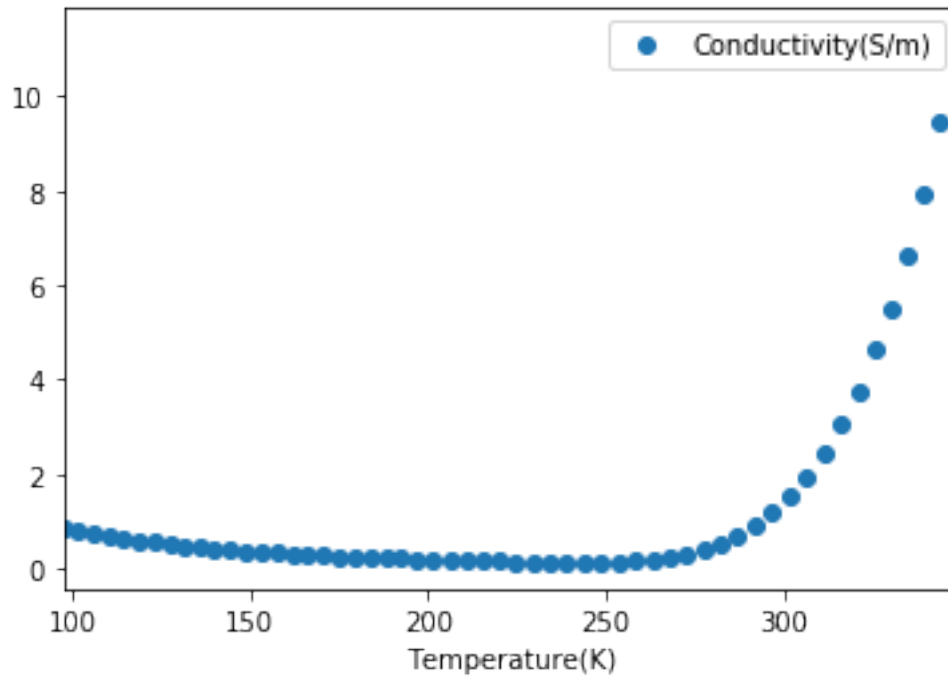


```
[61]: # Plot of conductivity for no magnetic field.
import matplotlib.pyplot as plt
conductivity_BOff = [1/rho_BOff[x] for x in range(index_length)]
run1_BOff['Conductivity(S/m)'] = conductivity_BOff
run1_BOff.plot(x='Temperature(K)', y="Conductivity(S/m)", style = 'o')
# run1_BPos
```

C:\Users\Todde\Anaconda3\lib\site-packages\ipykernel_launcher.py:4:
 SettingWithCopyWarning:
 A value is trying to be set on a copy of a slice from a DataFrame.
 Try using .loc[row_indexer,col_indexer] = value instead

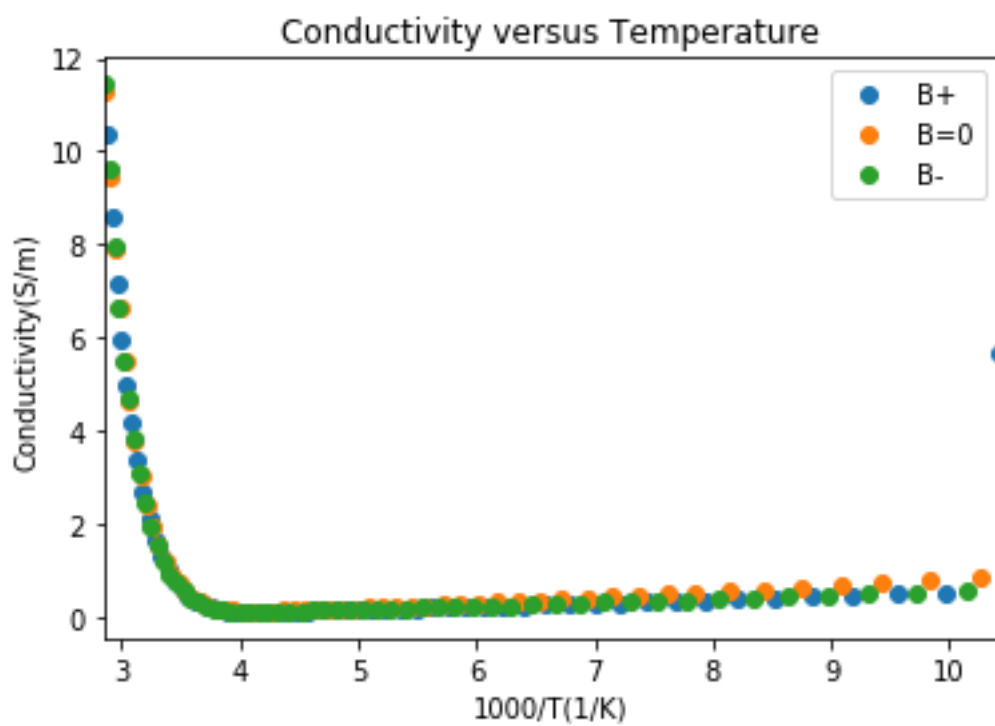
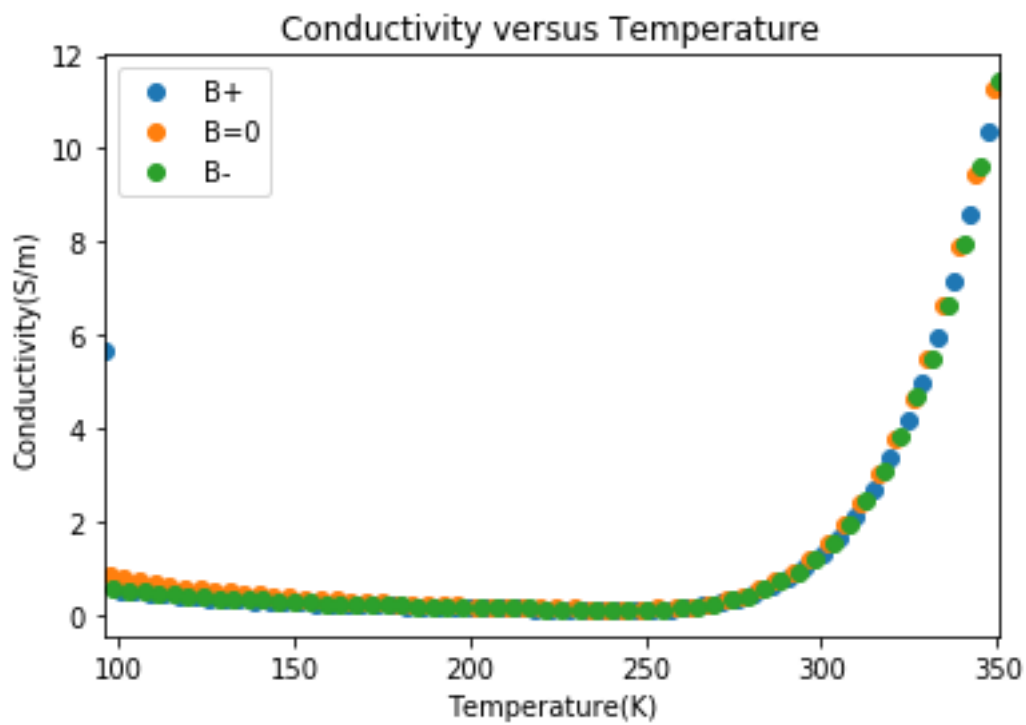
See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
 after removing the cwd from sys.path.

```
[61]: <matplotlib.axes._subplots.AxesSubplot at 0x180d576e488>
```



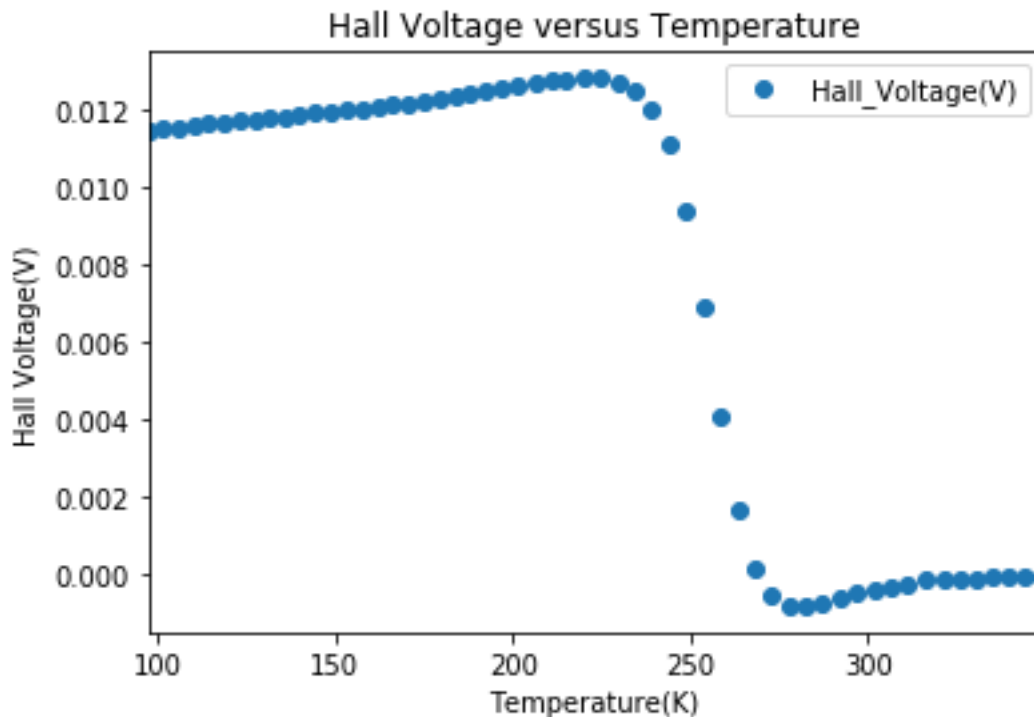
```
[62]: # The conductivity plots with respect to temperature.
fig, ax = plt.subplots(facecolor='white')
run1_BPos.plot(x= 'Temperature(K)', y = 'Conductivity(S/m)', ax = ax, style = 'o')
run1_BOff.plot(x='Temperature(K)', y = 'Conductivity(S/m)', ax = ax, style = 'o')
run1_BNeg.plot(x='Temperature(K)', y = 'Conductivity(S/m)', ax = ax, style = 'o')
ax.set_ylabel("Conductivity(S/m)")
ax.set_title("Conductivity versus Temperature")
ax.legend(['B+', 'B=0', 'B-'])
fig, ax = plt.subplots(facecolor='white')
ax = run1_BPos.plot(x= '1000/T(1/K)', y = 'Conductivity(S/m)', ax = ax, style = 'o')
run1_BOff.plot(x='1000/T(1/K)', y = 'Conductivity(S/m)', ax = ax, style = 'o')
run1_BNeg.plot(x='1000/T(1/K)', y = 'Conductivity(S/m)', ax = ax, style = 'o')
ax.set_ylabel("Conductivity(S/m)")
ax.set_title("Conductivity versus Temperature")
ax.legend(['B+', 'B=0', 'B-'])
```

[62]: <matplotlib.legend.Legend at 0x180d5863e08>



```
[63]: # Computing the Hall voltage
V_BD_Pos = [(run1_BPos.iloc[x]['V_BD']-run1_BPos.iloc[x]['V_-BD'])/2 for x in
→range(index_length)]
V_AC_Pos = [(run1_BPos.iloc[x]['V_AC']-run1_BPos.iloc[x]['V_-AC'])/2 for x in
→range(index_length)]
V_BD_Neg = [(run1_BNeg.iloc[x]['V_BD']-run1_BNeg.iloc[x]['V_-BD'])/2 for x in
→range(index_length)]
V_AC_Neg = [(run1_BNeg.iloc[x]['V_AC']-run1_BNeg.iloc[x]['V_-AC'])/2 for x in
→range(index_length)]
V_BD = [(V_BD_Pos[x]-V_BD_Neg[x])/2 for x in range(index_length)]
V_AC = [(V_AC_Pos[x]-V_AC_Neg[x])/2 for x in range(index_length)]
V_H = [(V_BD[x]+V_AC[x])/2 for x in range(index_length)]
tempAve = [(run1_BPos.iloc[x]['Temperature(K)'] + run1_BNeg.
→iloc[x]['Temperature(K)'])/2 for x in range(index_length)]
InverseTemp = [1/tempAve[x] for x in range(index_length)]
Data = {'Temperature(K)': tempAve, 'Hall_Voltage(V)': V_H}
df = pd.DataFrame(Data, columns = ['Temperature(K)', 'Hall_Voltage(V)'])
fig, ax = plt.subplots(facecolor='white')
ax = df.plot(x= 'Temperature(K)', y = 'Hall_Voltage(V)', ax = ax, style = 'o' )
ax.set_ylabel("Hall Voltage(V)")
ax.set_title("Hall Voltage versus Temperature")
```

[63]: Text(0.5, 1.0, 'Hall Voltage versus Temperature')




```
[64]: # Plotting the hall coefficient
B = 0.5233
R_H = [(V_H[x]*d)/(I*B) for x in range(index_length)]
df['Hall_Coefficient(Ohm*m/Tesla)'] = R_H
df['1000/T (1/K)'] = InverseTemp
fig, ax = plt.subplots(facecolor='white')
ax = df.plot(x='Temperature(K)', y = 'Hall_Coefficient(Ohm*m/Tesla)', ax = ax,
→style = 'o')
ax.set_ylabel("Hall Coefficient(Ohm*m/Tesla)")
ax.set_title("Hall Coefficient versus Temperature")
fig, ax = plt.subplots(facecolor='white')
ax = df.plot(x='1000/T (1/K)', y = 'Hall_Coefficient(Ohm*m/Tesla)', ax = ax,
→style = 'o')
ax.set_ylabel("Hall Coefficient(Ohm*m/Tesla)")
ax.set_title("Hall Coefficient versus Inverse Temperature")
df
```

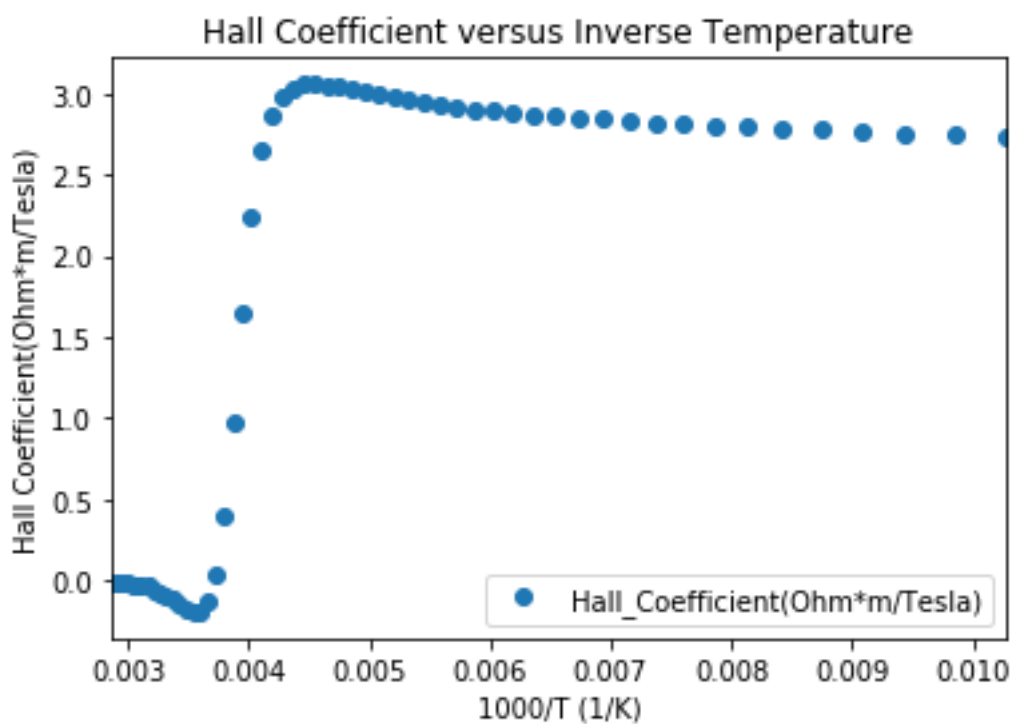
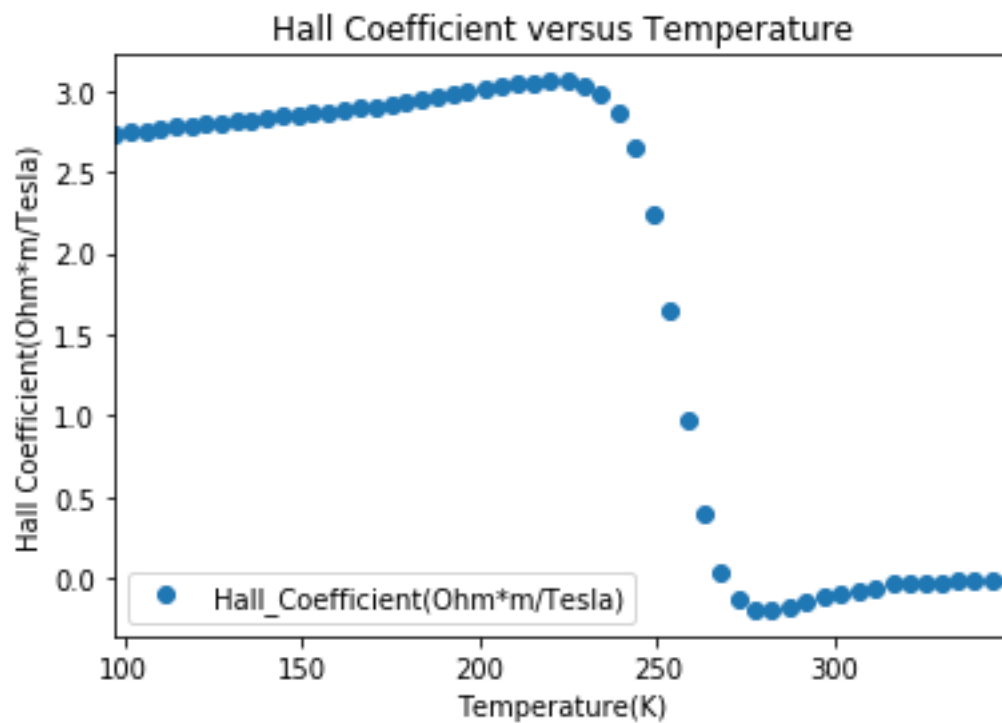
```
[64]:
```

	Temperature(K)	Hall_Voltage(V)	Hall_Coefficient(Ohm*m/Tesla)	\
0	97.3400	0.011445	2.733969	
1	101.5950	0.011492	2.745055	
2	105.9650	0.011537	2.755790	
3	110.1425	0.011580	2.766156	
4	114.3400	0.011622	2.776225	
5	118.7275	0.011664	2.786117	
6	123.0450	0.011705	2.796027	
7	127.2600	0.011743	2.804919	
8	131.4600	0.011780	2.813939	
9	135.6525	0.011818	2.822855	
10	139.9000	0.011856	2.831968	
11	144.2725	0.011895	2.841349	
12	148.7200	0.011940	2.852033	
13	153.1100	0.011984	2.862513	
14	157.5225	0.012026	2.872581	
15	161.8425	0.012068	2.882674	
16	166.1700	0.012111	2.893011	
17	170.5925	0.012156	2.903808	
18	175.0000	0.012211	2.916918	
19	179.3425	0.012268	2.930513	
20	183.6900	0.012329	2.945006	
21	188.0875	0.012393	2.960372	
22	192.3775	0.012456	2.975441	
23	196.6925	0.012524	2.991568	
24	201.4200	0.012592	3.007862	
25	206.1750	0.012659	3.023878	
26	210.7000	0.012717	3.037682	
27	215.1250	0.012764	3.048974	
28	219.9500	0.012802	3.057878	

29	224.7250	0.012786	3.054211
30	229.5250	0.012710	3.035923
31	234.2500	0.012496	2.984799
32	239.0250	0.012020	2.871083
33	243.7750	0.011078	2.646232
34	248.6750	0.009369	2.237943
35	253.6000	0.006867	1.640261
36	258.4250	0.004058	0.969290
37	263.2500	0.001673	0.399553
38	268.0500	0.000156	0.037323
39	272.8000	-0.000575	-0.137311
40	277.6000	-0.000813	-0.194138
41	282.3750	-0.000812	-0.194006
42	287.1500	-0.000719	-0.171836
43	291.9500	-0.000604	-0.144307
44	296.8250	-0.000490	-0.117117
45	301.6500	-0.000394	-0.094216
46	306.4500	-0.000316	-0.075465
47	311.3250	-0.000250	-0.059663
48	316.2500	-0.000154	-0.036819
49	321.1750	-0.000159	-0.038091
50	325.8750	-0.000128	-0.030590
51	330.1250	-0.000106	-0.025401
52	334.6250	-0.000088	-0.020925
53	339.3250	-0.000070	-0.016685
54	344.1000	-0.000057	-0.013684
55	348.9000	-0.000048	-0.011358

	1000/T (1/K)
0	0.010273
1	0.009843
2	0.009437
3	0.009079
4	0.008746
5	0.008423
6	0.008127
7	0.007858
8	0.007607
9	0.007372
10	0.007148
11	0.006931
12	0.006724
13	0.006531
14	0.006348
15	0.006179
16	0.006018
17	0.005862

18	0.005714
19	0.005576
20	0.005444
21	0.005317
22	0.005198
23	0.005084
24	0.004965
25	0.004850
26	0.004746
27	0.004648
28	0.004546
29	0.004450
30	0.004357
31	0.004269
32	0.004184
33	0.004102
34	0.004021
35	0.003943
36	0.003870
37	0.003799
38	0.003731
39	0.003666
40	0.003602
41	0.003541
42	0.003483
43	0.003425
44	0.003369
45	0.003315
46	0.003263
47	0.003212
48	0.003162
49	0.003114
50	0.003069
51	0.003029
52	0.002988
53	0.002947
54	0.002906
55	0.002866



```
[65]: # Plot of the hole concentration in the extrinsic region
e = 1.602e-19
p_ext = [1/(e*R_H[x]*1) for x in range(index_length)]
p_ext
```

```
[65]: [2.2831997834756086e+18,
2.2739785920320212e+18,
2.2651211462216392e+18,
2.256632006189233e+18,
2.2484480561134953e+18,
2.240464906957663e+18,
2.2325239411482022e+18,
2.2254466053813263e+18,
2.2183127797757507e+18,
2.2113064058499853e+18,
2.2041907582205076e+18,
2.1969129599788805e+18,
2.1886835638746867e+18,
2.1806702547662152e+18,
2.1730270674258237e+18,
2.1654193276673516e+18,
2.1576820474905902e+18,
2.1496594070474883e+18,
2.1399971609919665e+18,
2.130069739228156e+18,
2.1195869552637412e+18,
2.1085856536816497e+18,
2.0979063618382769e+18,
2.0865971927093627e+18,
2.0752939256040466e+18,
2.0643020090604562e+18,
2.054921548152095e+18,
2.047310712696837e+18,
2.0413494185660106e+18,
2.0438000947722954e+18,
2.0561119376826972e+18,
2.0913291884037059e+18,
2.1741615359850893e+18,
2.358899827410647e+18,
2.7892564602420004e+18,
3.8056128257606323e+18,
6.439965765453345e+18,
1.5622962795963253e+19,
1.6724694132334582e+20,
-4.546038590344711e+19,
-3.2153474623445803e+19,
-3.21752484269615e+19,
```

```
-3.632644251158684e+19,
-4.325650251483184e+19,
-5.329866323021168e+19,
-6.625425513538134e+19,
-8.27168935088163e+19,
-1.046234994766201e+20,
-1.6953911009178678e+20,
-1.638776175073938e+20,
-2.0405922562633702e+20,
-2.4574900276734722e+20,
-2.98314321709735e+20,
-3.7412075278128546e+20,
-4.561611971507361e+20,
-5.495759112885969e+20]
```

```
[66]: # Define function for calculating a power law
powerlaw = lambda x, amp, index: amp * (x**index)
run1_extr_BPos = run1_BPos.loc[(run1_BPos['Temperature(K)'] < 240)]
xdata = run1_extr_BPos['Temperature(K)'].tolist()
ydata = run1_extr_BPos['Resistivity(Ohm)'].tolist()
r = len(xdata)
yerr = [0.01 * ydata[x] for x in range(r)] # simulated
      ↪ errors (1%)
```

```
[67]: #####
# Fitting the data -- Least Squares Method
#####

# Power-law fitting is best done by first converting
# to a linear equation and then fitting to a straight line.
# Note that the `logyerr` term here is ignoring a constant prefactor.
#
#  $y = a * x^b$ 
#  $\log(y) = \log(a) + b * \log(x)$ 
#
import matplotlib.pyplot as plt
from scipy import optimize
from scipy.optimize import leastsq

logx = np.log10(xdata)
logy = np.log10(ydata)
logyerr = [yerr[x] / ydata[x] for x in range(r)]

# define our (line) fitting function
fitfunc = lambda p, x: p[0] + p[1] * x
errfunc = lambda p, x, y, err: (y - fitfunc(p, x)) / err
```

```

pinit = [1.0, -1.0]
out = optimize.leastsq(errfunc, pinit,
                       args=(logx, logy, logyerr), full_output=1)

pfinal = out[0]
covar = out[1]
print(pfinal)
print(covar)

index = pfinal[1]
amp = 10.0*pfinal[0]
print(amp)
print(index)

indexErr = np.sqrt( covar[1][1] )
ampErr = np.sqrt( covar[0][0] ) * amp
print(ampErr)
print(indexErr)
#####
# Plotting data
#####

plt.clf()
plt.subplot(2, 1, 1)
plt.plot(xdata, powerlaw(xdata, amp, index))      # Fit
plt.errorbar(xdata, ydata, yerr=yerr, fmt='k.')  # Data
plt.text(100, 6.5, 'Ampli = %5.2f +/- %5.2f' % (amp, ampErr))
plt.text(100, 5.5, 'Index = %5.2f +/- %5.2f' % (index, indexErr))
plt.title('Best Fit Power Law')
plt.xlabel('X')
plt.ylabel('Y')

plt.subplot(2, 1, 2)
plt.loglog(xdata, powerlaw(xdata, amp, index))
plt.errorbar(xdata, ydata, yerr=yerr, fmt='k.')  # Data
plt.xlabel('X (log scale)')
plt.ylabel('Y (log scale)')

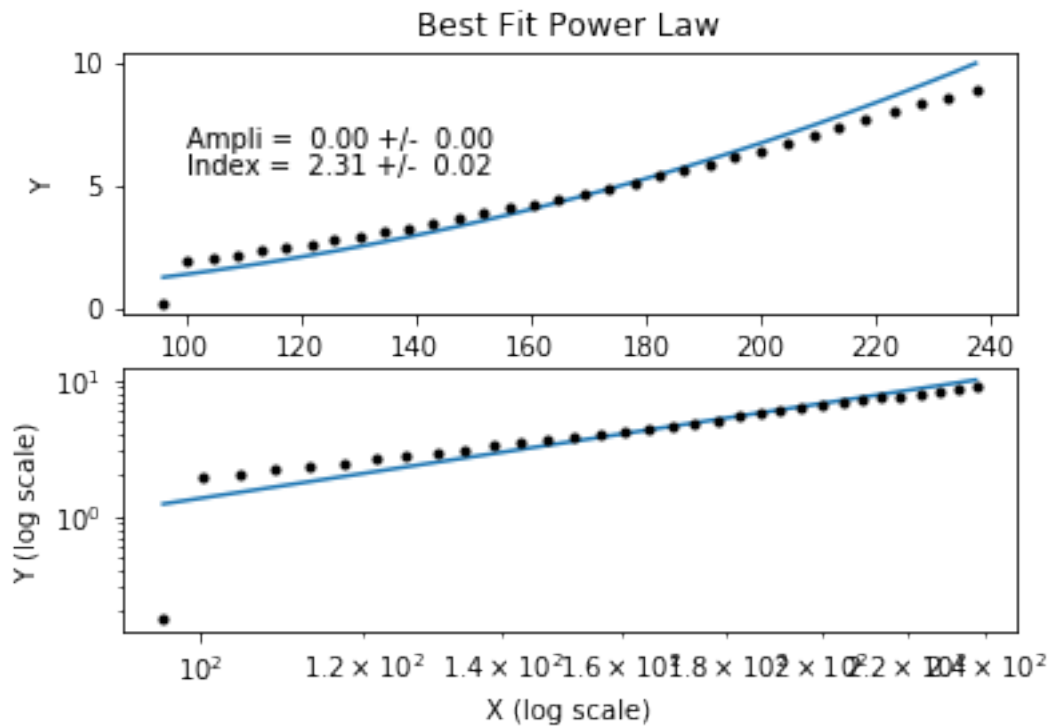
```

```

[-4.4853483  2.30826327]
[[ 0.00112104 -0.00050729]
 [-0.00050729  0.00023018]]
3.270782772608476e-05
2.308263274402046
1.0951206466419913e-06
0.015171817789088167

```

```
[67]: Text(0, 0.5, 'Y (log scale)')
```



```
[68]: # Plotting the Hall mobility
conductivity = [1/((rho_BPos[x]+rho_BNeg[x])/2) for x in range(index_length)]
mu_H = [R_H[x]*conductivity[x] for x in range(index_length)]
temp = df['Temperature(K)']
df['Hall_Mobility(m^2/(V*s))'] = mu_H
fig, ax = plt.subplots(facecolor='white')
ax = df.plot(x='Temperature(K)', y='Hall_Mobility(m^2/(V*s))', ax=ax, style='o')
ax.set_title("Hall Mobility versus Temperature")
ax.set_ylabel("Hall Mobility(m^2/(V*s))")
df
```

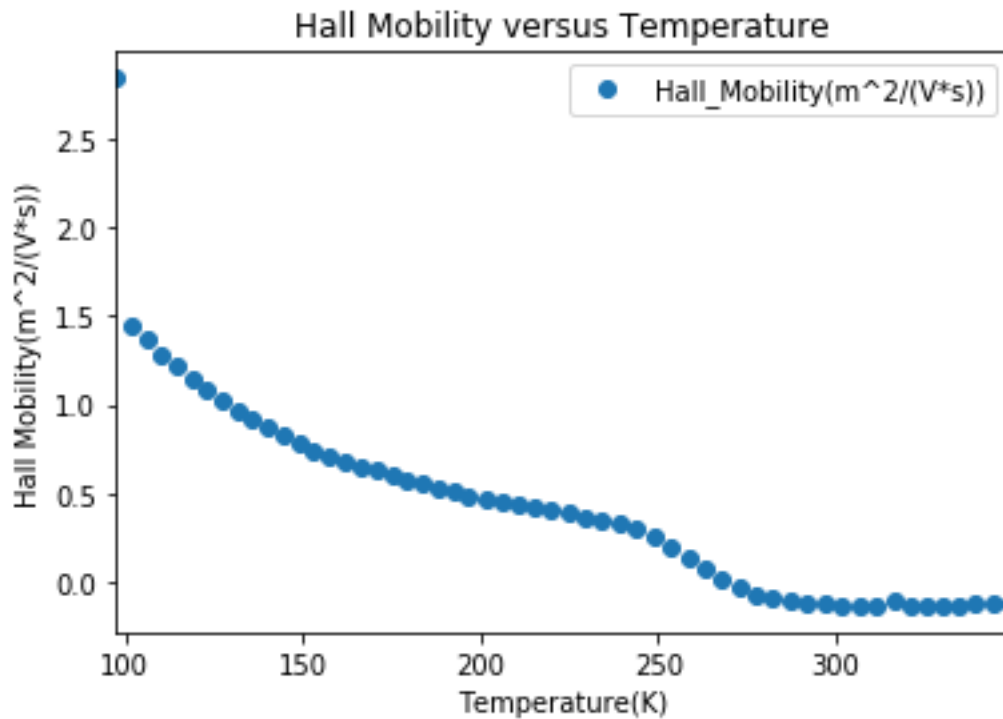
```
[68]:
```

	Temperature(K)	Hall_Voltage(V)	Hall_Coefficient(Ohm*m/Tesla)	\
0	97.3400	0.011445	2.733969	
1	101.5950	0.011492	2.745055	
2	105.9650	0.011537	2.755790	
3	110.1425	0.011580	2.766156	
4	114.3400	0.011622	2.776225	
5	118.7275	0.011664	2.786117	
6	123.0450	0.011705	2.796027	
7	127.2600	0.011743	2.804919	
8	131.4600	0.011780	2.813939	

9	135.6525	0.011818	2.822855
10	139.9000	0.011856	2.831968
11	144.2725	0.011895	2.841349
12	148.7200	0.011940	2.852033
13	153.1100	0.011984	2.862513
14	157.5225	0.012026	2.872581
15	161.8425	0.012068	2.882674
16	166.1700	0.012111	2.893011
17	170.5925	0.012156	2.903808
18	175.0000	0.012211	2.916918
19	179.3425	0.012268	2.930513
20	183.6900	0.012329	2.945006
21	188.0875	0.012393	2.960372
22	192.3775	0.012456	2.975441
23	196.6925	0.012524	2.991568
24	201.4200	0.012592	3.007862
25	206.1750	0.012659	3.023878
26	210.7000	0.012717	3.037682
27	215.1250	0.012764	3.048974
28	219.9500	0.012802	3.057878
29	224.7250	0.012786	3.054211
30	229.5250	0.012710	3.035923
31	234.2500	0.012496	2.984799
32	239.0250	0.012020	2.871083
33	243.7750	0.011078	2.646232
34	248.6750	0.009369	2.237943
35	253.6000	0.006867	1.640261
36	258.4250	0.004058	0.969290
37	263.2500	0.001673	0.399553
38	268.0500	0.000156	0.037323
39	272.8000	-0.000575	-0.137311
40	277.6000	-0.000813	-0.194138
41	282.3750	-0.000812	-0.194006
42	287.1500	-0.000719	-0.171836
43	291.9500	-0.000604	-0.144307
44	296.8250	-0.000490	-0.117117
45	301.6500	-0.000394	-0.094216
46	306.4500	-0.000316	-0.075465
47	311.3250	-0.000250	-0.059663
48	316.2500	-0.000154	-0.036819
49	321.1750	-0.000159	-0.038091
50	325.8750	-0.000128	-0.030590
51	330.1250	-0.000106	-0.025401
52	334.6250	-0.000088	-0.020925
53	339.3250	-0.000070	-0.016685
54	344.1000	-0.000057	-0.013684
55	348.9000	-0.000048	-0.011358

	1000/T (1/K)	Hall_Mobility(m ² /(V*s))
0	0.010273	2.842716
1	0.009843	1.452403
2	0.009437	1.363583
3	0.009079	1.284408
4	0.008746	1.212088
5	0.008423	1.140884
6	0.008127	1.076857
7	0.007858	1.018840
8	0.007607	0.964965
9	0.007372	0.915242
10	0.007148	0.868672
11	0.006931	0.824046
12	0.006724	0.780994
13	0.006531	0.741738
14	0.006348	0.708096
15	0.006179	0.679761
16	0.006018	0.652595
17	0.005862	0.624959
18	0.005714	0.598097
19	0.005576	0.572567
20	0.005444	0.548625
21	0.005317	0.526078
22	0.005198	0.505439
23	0.005084	0.486127
24	0.004965	0.466242
25	0.004850	0.447393
26	0.004746	0.430370
27	0.004648	0.414850
28	0.004546	0.398980
29	0.004450	0.383269
30	0.004357	0.366299
31	0.004269	0.348176
32	0.004184	0.326538
33	0.004102	0.297946
34	0.004021	0.256726
35	0.003943	0.201113
36	0.003870	0.135168
37	0.003799	0.067555
38	0.003731	0.008046
39	0.003666	-0.038843
40	0.003602	-0.072775
41	0.003541	-0.096258
42	0.003483	-0.112309
43	0.003425	-0.122919
44	0.003369	-0.129488

45	0.003315	-0.133543
46	0.003263	-0.135643
47	0.003212	-0.135793
48	0.003162	-0.105283
49	0.003114	-0.135878
50	0.003069	-0.134728
51	0.003029	-0.133432
52	0.002988	-0.131214
53	0.002947	-0.125996
54	0.002906	-0.124107
55	0.002866	-0.123724



```
[69]: # The data to be used in the power fit.
df_ext = df.loc[(df['Temperature(K)'] < 240)]
xdata = df_ext['Temperature(K)'].tolist()
ydata = df_ext['Hall_Mobility(m^2/(V*s))'].tolist()
yerr = [ydata[x]*0.01 for x in range(r)]
```

```
[70]: # Getting the power fit to actually work.
logx = np.log10(xdata)
logy = np.log10(ydata)
logyerr = [yerr[x] / ydata[x] for x in range(r)]
```

```

# define our (line) fitting function
fitfunc = lambda p, x: p[0] + p[1] * x
errfunc = lambda p, x, y, err: (y - fitfunc(p, x)) / err

pinit = [1.0, -1.0]
out = optimize.leastsq(errfunc, pinit,
                       args=(logx, logy, logyerr), full_output=1)

pfinal = out[0]
covar = out[1]

index = pfinal[1]
amp = 10.0**pfinal[0]
print(amp)
print(index)

indexErr = np.sqrt( covar[1][1] )
ampErr = np.sqrt( covar[0][0] ) * amp
print(ampErr)
print(indexErr)

#####
# Plotting data
#####

plt.clf()
plt.subplot(2, 1, 1)
plt.plot(xdata, powerlaw(xdata, amp, index))      # Fit
plt.errorbar(xdata, ydata, yerr=yerr, fmt='k.')  # Data
plt.text(100, 2.5, 'Ampli = %5.2f +/- %5.2f' % (amp, ampErr))
plt.text(100, 2, 'Index = %5.2f +/- %5.2f' % (index, indexErr))
plt.title('Best Fit Power Law')
plt.xlabel('X')
plt.ylabel('Y')

plt.subplot(2, 1, 2)
plt.loglog(xdata, powerlaw(xdata, amp, index))
plt.errorbar(xdata, ydata, yerr=yerr, fmt='k.')  # Data
plt.xlabel('X (log scale)')
plt.ylabel('Y (log scale)')

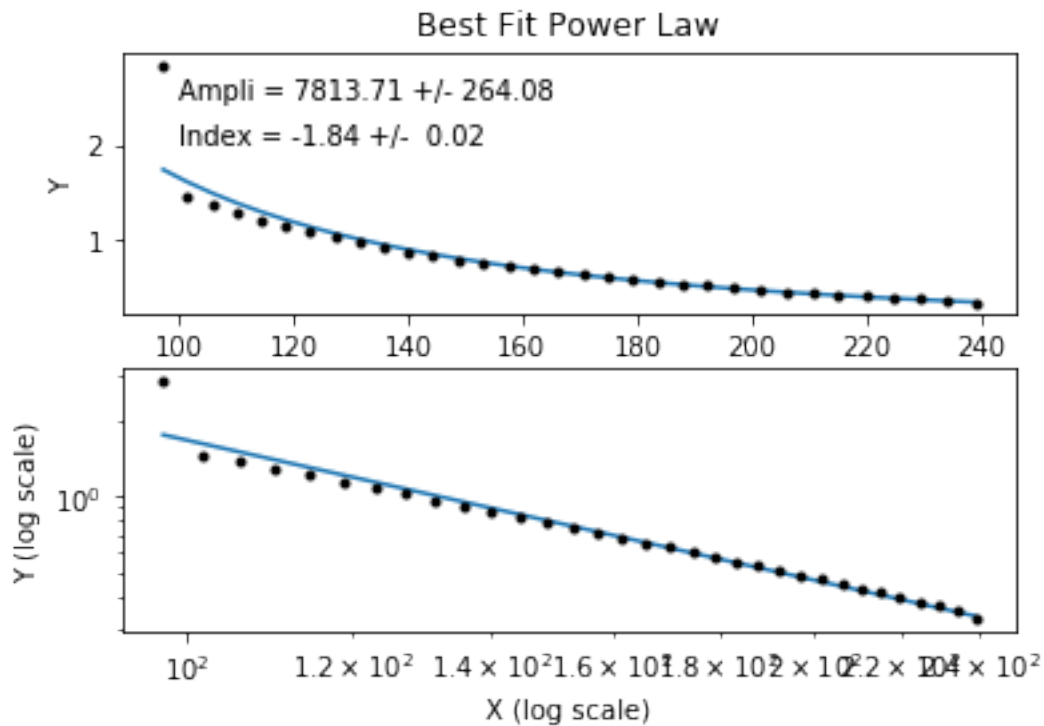
```

```

7813.709871158608
-1.8366688743414112
264.083383247036
0.015288789380554977

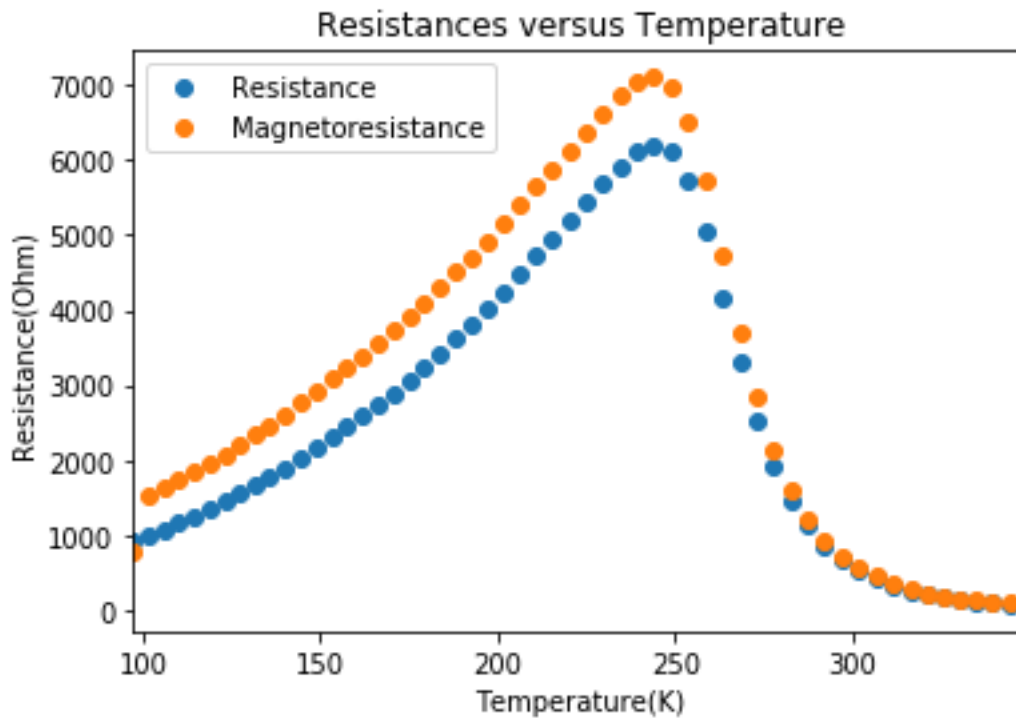
```

```
[70]: Text(0, 0.5, 'Y (log scale)')
```



```
[71]: # The initial goal here is to separate out the resistances and the
      ↪magnetoresistances.
d = 1.25e-3
deltad=0.1e-3
# Normal resistance with no magnetic field.
R = [rho_BOff[x]/d for x in range(index_length)]
# Magnetoresistance
R_M = [(rho_BNeg[x]+rho_BPos[x])/(2*d) for x in range(index_length)]
resistanceData = {'Temperature(K)': tempAve, 'Resistance(Ohm)': R,
      ↪'Magnetoresistance(Ohm)': R_M}
resistanceDF = pd.DataFrame(resistanceData, columns = ['Temperature(K)',
      ↪'Resistance(Ohm)', 'Magnetoresistance(Ohm)'])
resistanceDF
fig, ax = plt.subplots(facecolor='white')
ax = resistanceDF.plot(x= 'Temperature(K)', y = 'Resistance(Ohm)', ax = ax,
      ↪style = 'o' )
resistanceDF.plot(x='Temperature(K)', y = 'Magnetoresistance(Ohm)', ax = ax,
      ↪style = 'o')
ax.set_ylabel("Resistance(Ohm)")
ax.set_title("Resistances versus Temperature")
ax.legend(['Resistance', 'Magnetoresistance'])
```

[71]: <matplotlib.legend.Legend at 0x180d59f7608>



[72]: *# Computing the Resistance for the extrinsic region. Computed in m.*

```
l = .01
A = 1*0.00125
c = np.exp(-7.618008312233084)
a = 1.787829022695471
rho = lambda T: c*T**a
R_e = (rho(270)*l)/A
print(R_e)
# Computed at T=272.8K, for resi
R_0 = (3.412274*l)/A
print(R_0)
b = R_e/(R_e-R_0)
print(b)
```

```
8739.643471017485
2729.8192
1.4542261265715564
```